ANATOMY

SCIENTIFIC AND POPULAR

BY

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ILLUSTRATED

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"MALE AND FEMALE CREATED HE THEM."—*Gen.* i. 27.

PREFACE.

THIS work is offered to the public, including families, mechanics, artisans, and the general student, as well as members of the medical profession and medical students; not with the desire to supplant other valuable works, but with the hope of *extending among the whole people* a better knowledge of the human body, which has been called the "temple of the living God."

A correct medical education is the direct path toward physical perfection; and some knowledge of the *structure* of the physical body is the necessary basis of a correct medical education. As the common mind advances, the medical profession will necessarily advance. Knowledge is the birthright of every human being; and no knowledge is more useful than that of the human organization, and the subtile and mysterious force (or mind) that governs it. "Know thyself," said the Greek sage, "descended from heaven to be engraven upon the tablet of enduring memory."

What *self* is, no one has yet been able to tell us. Man is a being of such proportions (considered mentally) and complexity, that he completely baffles description, and we shall not attempt it here. Whether he is spirit or matter, either or both, as many philosophers claim and deny, we do not now affirm. That he *has a body*, and lives in a world of cause and effect, is evident. The body is constructed on strictly mechanical principles, and is well considered as an instrument for use in the material world, or as a tenement which man holds in his present mode of being. It is our

object in this volume to call attention to the structure of this tenement, or instrument, in such a manner that through a better and more general knowledge of its nature the readers may be enabled to enjoy the use of better instruments, and eventually fulfill the scriptural request to "present your bodies a living sacrifice, holy and acceptable unto God, which is your reasonable service." One *peculiar feature* of the work is the *explanation* of all technical and difficult terms in plain English, which serves to make this heretofore difficult study accessible to all.

The figure on the title-page is in the form of a spherical triangle, of which use is made in the higher department of mathematics. It bears the words, "Quæ prosunt omnibus" (which are useful to all); and contains the wand of Mercury (the caduceus), to which ancient poets attributed wonderful powers. The rod represents power, the serpents (in the old Coptic language), wisdom, and the wings, aspiration, or diligence and activity.

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General Introduction.

THE *cell* is the *material* starting-point of every human organism; and, in some form, makes up the structure of all organic bodies, both animal and vegetable.

The typical organic cell consists from without inward of cell membrane, protoplasmic contents, nucleus, and nucleolus. Whether the cell-membrane is anything more than the wall, or outer surface of the protoplasm, is open to further investigation. The composition of the protoplasm (the fluidic contents of the cell) varies with the age of the cell. At first it consists of a homogeneous albuminoid (resembling albumen, like the white of an egg); but later there appear granulations, coloring, or fatty matter, and the whole may become hardened into horn, or bone. The nucleus (kernel) examined with the microscope presents the appearance of a sphere, the contents of which are more or less liquid and transparent.

The nucleus is surrounded by a capsule, so thin and transparent that its presence is demonstrated chiefly by the current observable in its contents.

In the interior of the nucleus of the most perfect cell is discernible with the microscope a brilliant central point, or globule, called the nucleolus (little nucleus). In some cells there are two or three brilliant points, or nucleoli (plural of nucleus).

The nucleolus is of later formation, and results from the differentiation (development of variety) in the liquid mass of the nucleus.

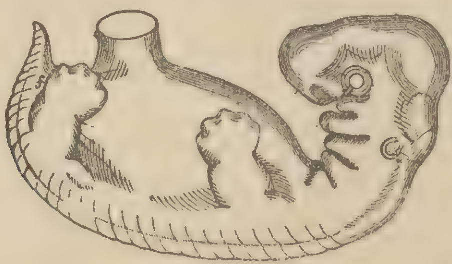
Some cells go through their whole period of existence without ever possessing a nucleolus. The nucleus and nucleolus are endowed with increased vital power, and are able to resist the action of acids and alkalies that destroy the body of the cell.

Bioplasm (life-formed) is another and perhaps better name for that which is called protoplasm (first-formed).

Every organic parent cell is endowed with vital properties, motion, nutrition, reproduction, etc., but the most remarkable property of cells is that of differentiation; so that out of cells which are to all appearance identical, are developed all the different tissues and fluids of the body;

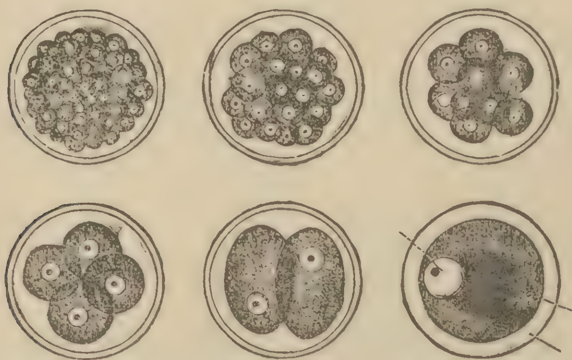
and in the growth and development of the body, from the parent cell to the perfected organism, there is constantly increasing evidence of that wondrous power known to man as *Life*. In the earlier stages of development it is impossible to distinguish the worm from the philosopher. We give below the figure of the human embryo of seven week's development.

Fig. 1.



Cells are multiplied by a process known as segmentation (splitting, or dividing), or by gemmation (budding). In the former process the

Fig. 2.



THE CELL, OR OVUM, IN SUCCESSIVE STAGES OF DEVELOPMENT (MAGNIFIED).

nucleus splits, and forms two; in the latter, the cell sends off a process, or bud, and thus new nuclei (plural of nucleus) are produced, which become detached from the parent cell, and surrounded by their own cell substance.

The continuous development of cells in the formation of tissues, was called by Virchow "proliferation (bearing of offspring) of cells."

The nucleus is sometimes called the cytoblast (cell-germ).

By Professor Agassiz the *cell-wall* was termed "ectoblast" (outer

germ); the *nucleus* was the "mesoblast" (middle germ); and the *nucleolus* was the "entoblast" (inner germ).

Lymph and chyle corpuscles (little bodies) were termed by Henle "leucocytes" (white cells); and when the white cells of the blood predominate, or there is a deficiency of coloring matter, or a deficiency of red corpuscles in the blood, the condition is termed "lucæmia" (white blood), or leucocythemia (white-cell blood).

FLUIDS.

The **fluids** of the body are the chyle ("juice"), which is absorbed by the mucous membrane of the small intestine; the lymph (a clear fluid, like water), which is conveyed by the lymphatic vessels; the blood, which is conveyed by the arteries, capillaries, and veins; and the various secretions. The secretions will be mentioned further, in connection with the various organs and membranes that secrete them. The fluids are about nine times the amount of solids. The semi-solids, or soft parts, make up the rest of the body.

CHYLE.

The **chyle** is a milk-white fluid that in some respects resembles the blood. Like the blood, it coagulates on standing, and, like the blood, contains white corpuscles (little bodies). It is at first merely an emulsion, formed by the action of the pancreatic juice and bile upon the fatty matters of the food taken; but after passing through the mesenteric glands, the chyle contains chyle corpuscles. These corpuscles are identical with the white corpuscles of the blood.

Lymph.—The lymph is the liquid portion of the blood transuded from the capillaries during the process of nutrition, and returned again to the circulation through the lymphatic vessels. It resembles the plasma, or the serum, according as it contains more or less fibrin.

THE BLOOD.

(LATIN—"*Sanguis.*")

The blood is an animal fluid, and is pre-eminently vital. Its amount in the body, according to Harvey, who is credited with the discovery of its circulation, is about eight pounds. Haller estimated it as high as thirty pounds. More recent authors fix it at about one thirteenth of the weight of the body. (It is certain that Michael Servetus, a Spanish physician who suffered martyrdom in the time of Calvin, understood the circulation through the lungs *before the time of Harvey*, but the latter demonstrated the *systemic* circulation.)

The blood undergoes great changes in the lungs; but the most evident is a change in color from dark red, or purple, to a bright red, or scarlet. This change is due to the oxidation (absorption of oxygen) and decarbonization (removal of carbon) of the blood in the lungs.

Examined with the microscope the blood appears to be full of cells, more or less flattened, which have received the name of blood corpuscles (little bodies), blood discs (plates), or blood globules (little globes).

Fig. 3.

BLOOD CORPUSCLES AS THEY APPEAR UNDER THE MICROSCOPE.

These bodies, or cells, are of two kinds, and are distinguished by their color, as the *white* and the *red* corpuscles. The white are properly lymph corpuscles, which are as yet immature, and freshly received into the blood.

The specific gravity of the blood is about 1,055, water being 1,000. *Arterial* blood is somewhat lighter than *venous* blood, the difference being chiefly in the relative weight and change of quantity of the oxygen and carbon which each contains. Tested chemically, the blood is slightly alkaline. It is a composite fluid, and is the common carrier of waste and supply in the entire body, or at least in all parts supplied with blood-vessels (arteries and veins). Drawn from the living vessels, and allowed to stand, blood soon (ordinarily in five minutes) separates into two parts—a fluid called "*serum,*" and a "clot" (coagulum, or crassamentum). The clot consists of the blood corpuscles, inclosed in a substance known as "fibrin" (from fiber) which is held in solution in the blood, and is sometimes called by physicians "coagulable lymph" (a clear fluid capable of clotting.) The liquid portion of the blood, as it circulates in the vessels of the body, is called the "plasma" (something "formed,") or "liquor sanguinis" (fluid of the blood.) The *plasma* holds fibrin in solution; the *serum* does not. Neither plasma nor serum contains properly any blood corpuscles. The latter composes about one

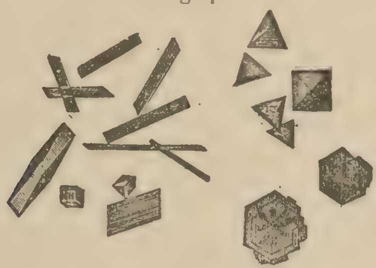
third the volume of the blood, and the plasma, two thirds. The fibrin of the blood varies from one to four per cent.

The red globules are far more numerous than the white, but vary considerably in proportion. One white corpuscle to three or four hundred of the red, is the ordinary proportion. These little bodies (corpuscles) are so small that it takes from 2,000 to 3,000 placed side by side to measure an inch. (See Fig. 3.)

The serum of the blood is of a yellowish color, and contains so much albumen (a substance like the white of an egg) that it solidifies almost completely on being heated.

The coloring matter of the blood is termed "hæmatin" (blood matter). Treated by certain chemical re-agents, three kinds of micro-

Fig. 4.



BLOOD CRYSTALS.

scopic crystals, more or less resembling each other, can be obtained from hæmatin.

The philosophy of coagulation of the blood is not well understood. Under normal circumstances the blood does not clot in the living *blood-vessels,* and is generally supposed not to clot in the living body; but considering coagulation as nearly synonymous with the *formation* of *fibrin,* it seems to be logically conclusive that it does take place *within the body,* probably after transudation from the capillaries (microscopic tubes that lie at the termination of the arteries); for the fibrin so formed is an essential element of the tissues of the body. It constitutes the threads from which the tissues are woven.

GENERAL ANATOMY.

ANATOMY is the *science of structure.* The word is derived from the Greek, and signifies to "*cut up*," or dissect; as it was by dissecting animal bodies that their structure first became known.

But the facts of anatomy having been accurately observed and recorded, and the form and appearance of the various parts of the body having been modeled and illustrated by art, it is not essential that every student of this branch of natural science should take the same slow, tedious, and often unpleasant steps that led to its discovery and elucidation. By aid of the skeleton, charts, books, and illustrations, a very thorough knowledge of anatomy may be obtained; but practical skill in surgery ("hand-work," or manual operations) must be, in part, obtained by dissections. So long as the knife is to be used in surgery, there is nothing can take the place of experience.

Human Anatomy is the study of *human* structures, including male and female.

Comparative Anatomy compares the *structure of lower animals* with that of man.

Surgical Anatomy is the more careful study of certain parts, or regions, of the body, on account of their surgical importance.

Pathological, or Morbid Anatomy, is the study of structures *altered by disease;* as of cancers, tumors, etc.

General Anatomy, descriptive anatomy, and morphology (study of form), are synonymous terms, and include, not only the *form*, but also the *name*, *size*, and *situation* of the various structures and organs, but are *not* supposed to include *surgical* anatomy, which is special.

Histology (tissue-study) is sometimes considered synonymous with general anatomy,— the study of *all* the tissues,— but more commonly as synonymous with microscopic anatomy — the study of structures and tissues by aid of the microscope.

These terms are all used with reference to the study of the body while in a *state of rest;* while physiology (study of nature) studies the same *in motion*, as in life and health.

The body is composed of hard and soft parts, and contains within it fluids of different kinds. The study of the hard parts is sometimes called Skeletology (study of the skeleton), and the study of the soft parts, Sarcology (study of flesh).

Skeletology includes not only the study of the bones (Osteology), but also the study of the joints (Arthrology) and ligaments (Syndesmology); since the joints and ligaments form a part of the natural skeleton; and **Sarcology** includes Myology (study of the muscles), Neurology (study of the nerves), Angiology (study of vessels), Adenology (study of glands), Splanchnology (study of the viscera), and Dermatology (study of the skin)

The **natural skeleton** (dried-up body) is not convenient for the study of the bones which are concealed by the ligaments and parts dried down upon them; and for this reason an **artificial skeleton** (the natural bones held together by art) is used. The bones of the body weigh on an average about ten pounds. Calcined, the body is reduced to half a pound.

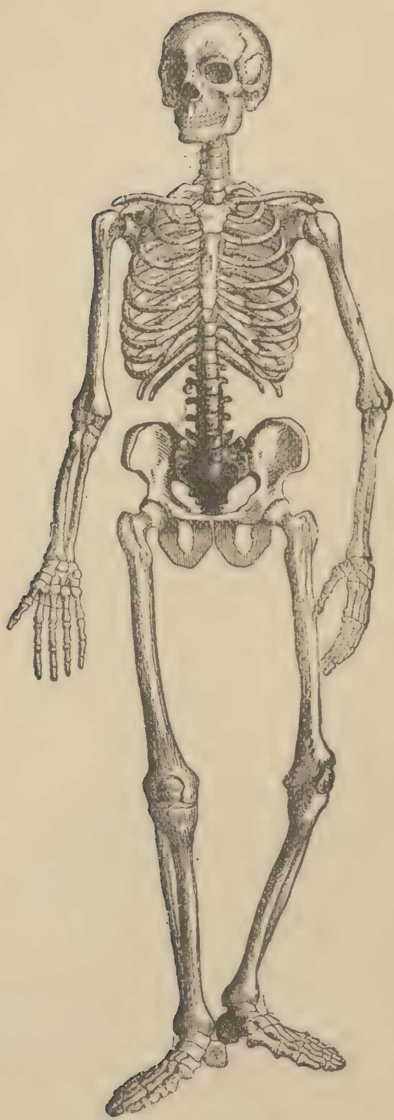
OSTEOLOGY (Study of the Bones).

The bony system is the framework of the body, and, considered separately, is called the skeleton. The skeleton contains two hundred or more bones; but the number varies somewhat in different individuals and at different periods of life. At birth many of the bones are cartilaginous, while others are composed of two or more pieces, connected by cartilage, or membrane; and in old age some of the bones become consolidated, especially the bones of the head. The bones give form and support to the body, serve to protect important organs, and are the levers, or passive organs of locomotion. The teeth differ in structure from the bones, and are, therefore, described separately.

The bones that form the vault of the skull, usually eight in number, sometimes contain one or more *extra pieces*, which have been called Wormian bones, in honor of Wormius, although **Andernach, of Strasburg,** previously mentioned them.

The knee-pans (patellæ) are developed in the tendons of the muscles that extend the leg, and being in the form of a grain of sesamum, are sometimes called "sesamoid" bones. Other sesamoid bones are generally found developed in some of the tendons of the hands and feet, but, not being constant, are not enumerated among the bones of

Fig. 5.



THE SKELETON.

the skeleton. The bones of the middle ear, six in number, three in each ear, in the adult, are sometimes included and sometimes omitted in the enumeration of the bones of the skeleton. If we omit the teeth, the Wormian bones, and the sesamoid in general, but include the knee-pans and the bones of the ear, we shall have in the adult 206 bones, which may be classified as follows, viz.: —

Bones of the head	28
" " trunk	54
" " upper extremities	64
" " lower "	60
Total	206

The hands and feet alone contain 106 bones — more than half the entire number; each foot having 26, and each hand 27.

The 28 bones of the head consist of 8 bones that form the walls and base of the cranium, 6 bones of the middle ear, and 14 bones of the face.

The 54 bones of the trunk comprise the bones of the spinal column (24 *vertebræ*, the *sacrum*, and *coccyx*), 12 pairs of ribs, the breast-bone, (*sternum*), the hyoid bone, found at the base of the tongue, and the two hip bones (*ossa innominata*.)

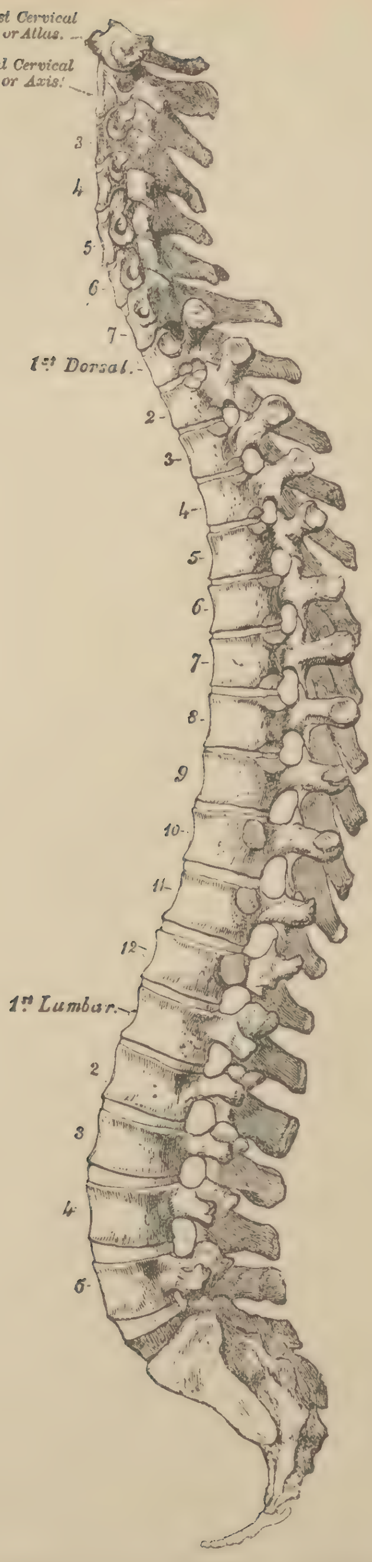
The 64 bones of the upper extremities are the two shoulder-blades (*scapulæ*), the two collar-bones (*clavicles*), the two bones of the arms (*humeri*), the two radii and the two ulnæ of the two forearms (the arm extends, in technical language, from the shoulder to the elbow, and the forearm from the elbow to the wrist), the 16 bones of the two wrists, the 10 bones of the two palms, and the 28 bones of the thumbs and fingers.

The 60 bones of the lower extremities include 2 thigh-bones (the *femora*), 2 knee-pans (*patellæ*), 2 tibiæ and 2 fibulæ of the legs, 14 bones in the two ankles, 10 in the two insteps, and 28 in the toes.

Some authors consider the shoulder (formed by the shoulder-blade and collar-bone) as the *connecting link between* the upper extremity and trunk, and thus enumerate only 30 bones in each upper extremity. The skull is often called the cranium (plural, crania,) and sometimes the calvaria (from *calvus*, "bald"). The wrist is called in Latin the *carpus*, and the wrist-bones are called *carpal* bones; while the bones of the palm of the hand are termed *metacarpal* (after or beyond the wrist) bones. The ankle is the *tarsus*, and the ankle-bones are the *tarsal* bones, while the five bones of the instep are the *metatarsal* bones.

The bones of the thumbs, fingers, and toes are called phalanges (plural of phalanx). A phalanx was a row, or body of soldiers, among

Fig. 6.



THE SPINAL COLUMN, OR "BACKBONE." (LATERAL VIEW.)

the Macedonians. There are in each hand and foot three rows (phalanges) of bones, but the thumbs and great toes do not extend into the third row (phalanx), having only 2 bones each.

The 54 bones of the trunk form the spinal column, the thorax (signifying "a cuirass," or coat of mail), and the pelvis (basin). The thorax, or chest, lodges and protects the chief organs of respiration and circulation. The spinal column, improperly called the backbone, is made up of 24 bones, called vertebræ (plural of vertebra), and 2 other bones, the sacrum and coccyx. The word vertebra signifies *to turn;* and the first vertebra really turns upon the second when we turn the head. The vertebræ are divided into three regions — the cervical (neck), dorsal (back), and lumbar (loin) vertebræ. There are 7 cervical, 12 dorsal, and 5 lumbar vertebræ. The ribs ("costæ," plural of costa) extend from the bodies of the vertebræ around the sides of the chest (thorax), and inclose the heart and lungs. Of the 206 bones, 172 are in pairs, leaving only 34 single bones. The single bones are all in the median line of the body, and for this reason are sometimes called mesial (middle) bones. The mesial bones are the frontal, occipital, sphenoid, ethmoid, vomer, inferior maxillary, hyoid, sternum, the 24 vertebræ, sacrum, and coccyx. These all extend as far on one side of the median line as the other, and give attachment to pairs of muscles. Of the 86 pairs, there are 30 pairs each in the upper and lower extremities, 12 pairs of ribs, 6 pairs of bones in the face, 3 pairs in the ears, 2 pairs in the skull, 2 pairs in the shoulders, and 1 pair of hip bones.

The 206 bones of the skeleton are all designated by the aid of **fifty names.** They are as follows: —

Phalanges (bones of the fingers and toes)	56 bones
Vertebræ (bones of the spinal column)	24 "
Ribs (called in Latin *costæ*)	24 "
Metatarsal (in the instep)	10 "
Metacarpal (in the palm of the hand)	10 "
Cuneiform (wedge form)	8 "
Scaphoid (skiff-like)	4 "
Parietal ("wall" of the skull)	2 "
Temporal ("time," from Latin *tempus*)	2 "
Superior Maxillary (upper jaw)	2 "
Malar ("apple," or cheek-bone)	2 "
Nasal (nose)	2 "
Lachrymal (tear)	2 "
Palate (roof of the mouth)	2 "
Inferior Turbinated (lower spongy bone of the nose)	2 "
Malleus ("hammer," small bone of the ear)	2 "
Incus ("anvil," small bone of the ear)	2 "
Stapes ("stirrup," small bone of the ear)	2 "

Clavicle (" little key," or collar-bone)	2 bones.
Scapula (shoulder-blade)	2 "
Humerus (arm)	2 "
Ulna (one of the bones of the fore-arm)	2 "
Radius (one of the bones of the fore-arm)	2 "
Semilunar (" half-moon," in the wrist)	2 "
Pisiform (" pea-form," in the wrist)	2 "
Trapezium (in the wrist)	2 "
Trapezoid (" like a trapezium," in the wrist)	2 "
Os magnum (" great bone" of the wrist)	2 "
Unciform (" hook-form," in the wrist)	2 "
Innominate (" nameless," hip-bone)	2 "
Femur (thigh)	2 "
Patella (knee-pan)	2 "
Tibia (one of the bones of the leg)	2 "
Fibula (one of the bones of the leg)	2 "
Os calcis (" heel-bone ")	2 "
Astragalus (Greek, a " die," in the ankle)	2 "
Cuboid (like a cube, in the ankle)	2 "
Frontal (of the skull)	1 "
Occipital (back part of the skull)	1 "
Sphenoid (" wedge-like," at the base of the brain)	1 "
Ethmoid (" sieve-like," between the eyeballs)	1 "
Vomer (" plow share," helps to divide the nasal cavities)	1 "
Inferior maxillary (lower jaw)	1 "
Hyoid (at the base of the tongue)	1 "
Sacrum (" sacred," back part of the pelvis)	1 "
Coccyx (" cuckoo," at the apex of the sacrum)	1 "
Sternum (" solid," the breast-bone)	1 "
Atlas (" sustainer," first vertebra)	1 "
Axis (" axle," around which the atlas turns)	1 "
Vertebra prominens (prominent vertebra, the seventh)	1 "

(The last three are numbered twice, being reckoned as vertebræ.)

The three bones of the ear (" ossicles," or little bones) lie within the cavity called the tympanum (drum), which is hollowed out in the petrous ("rocky," or hard) portion of the temporal bone on either side of the head at the base of the upper, or front brain. They are the malleus (hammer), incus (anvil), and stapes (stirrup), on each side.

Besides the ear-bones, which are *within* the bones of the cranium, but do not form a part of its walls, the cranium has 8 bones. They are the frontal, occipital, sphenoid, ethmoid, two temporal, and two parietal.

The 8 cuneiform bones are found in the ankles and wrists — 3 in each ankle and 1 in each wrist.

The 4 scaphoid bones are also found in the ankles and wrists — 1 in each wrist and ankle. Besides the scaphoid and 3 cuneiform, each ankle has 3 other bones — the astragalus, cuboid, and os calcis (heel-bone). The latter is sometimes called the calcaneum.

Besides the scaphoid and cuneiform, each wrist has 6 other bones — the semi-lunar, pisiform, trapezium, trapezoid, os magnum, and unciform.

Four bones enter into the formation of the pelvis. They are the 2 hip-bones, the sacrum, and the coccyx.

The shoulder has 2 bones, the scapula and clavicle. The arm has only 1 bone, the humerus. The fore-arm has 2 bones, the ulna and radius.

The hand has 27 bones — 8 in the wrist, 5 in the palm (metacarpal), and 14 in the thumb and fingers.

The cuneiform bones of the ankle are designated as internal, middle, and external cuneiform; or, first, second, and third cuneiform.

Two sesamoid bones are generally found at the base of each thumb and great toe. The sesamoid bones are developed in the tendons of muscles. We give below a tabular view of the bones. The bones of the head include the bones of the cranium and face.

Bones of the Cranium.

	1	Frontal,	Forming the walls of the cranium.
	1	Occipital,	
	1	Sphenoid,	
	1	Ethmoid,	
	2	Temporal,	
	2	Parietal,	
	6	Small ear-bones, 3 in each ear.	
Total,	14		

Bones of the Face.

	1	Vomer,
	1	Inferior maxillary,
	2	Superior maxillary,
	2	malar,
	2	lachrymal,
	2	palate,
	2	nasal,
	2	inferior turbinated.
Total,	14	

Bones of the Trunk.

	24	Vertebræ,
	24	Ribs,
	2	Hip *(ossa innominata).*
	1	Sternum,
	1	Hyoid,
	1	Sacrum,
	1	Coccyx.
Total,	54	

Bones of the Upper Extremity.

SHOULDER, { Scapula, Clavicle.

ARM — Humerus.

FOREARM, { Ulna, Radius.

WRIST, { Scaphoid, Semi-lunar, Cuneiform, Pisiform, Trapezium, Trapezoid, Os magnum, Unciform.

PALM — First, second, third, fourth, and fifth metacarpal bone.

THUMB AND FINGERS — Three phalanges, containing 14 bones. Total, 32 (on each side).

Bones of the Lower Extremity.

THIGH — Femur.

LEG, { Tibia, Fibula,

Knee-pan *(patella)*,

ANKLE, { Astragalus, Scaphoid, Cuboid, Os calcis, Three Cuneiform.

INSTEP — First, second, third, fourth, fifth metatarsal bone.

TOES — Three Phalanges, containing 14 bones. Total, 30 (in each lower extremity).

The bones are composed of animal and mineral matter in the proportion of one to two, differing somewhat in different parts of the body, in different individuals, and at different periods of life. The animal matter is mostly gelatine, and gives toughness and elasticity. The mineral matter, called also *earthy*, and *inorganic* matter, is chiefly phosphate and carbonate of lime. It gives hardness and solidity. In old age the earthy matter predominates; in youth, the animal matter. In rachitis (rickets) the mineral matter is usually deficient, and the bones lack firmness. Blood-vessels and nerves enter the bones, like other parts of the body. The arteries that supply the medullary canal of the long bones are called nutrient arteries.

The bones, except their cartilaginous extremities, are covered by a tough, fibrous membrane, called the periosteum (around the bone), which serves as a nidus (nest) for the ramification (branching) of vessels before entering the bone.

Bone is developed, for the most part, in temporary cartilage; but in the vault of the cranium and some other parts, in temporary membrane; and ossification commences by the deposition of mineral matter in the temporary membrane, or cartilage. The point where the mineral matter is first deposited is called the "punctum ossificationis" (point of ossification), or *center of ossification.* Some bones are developed from a single center, others from several centers. The sacrum has about thirty-five centers of ossification. The long bones have usually three or more centers: one for the shaft, and one or more for each end. The humerus is developed from seven centers; the ulna and radius, tibia and fibula, from *three* each. The femur has five centers of ossification; the patella usually one, but sometimes two. The frontal bone is developed from two centers, and at birth consists of two pieces, which usually unite in the median line. Each parietal bone is usually developed from a single center; while the occipital bone has four centers of ossification. The sternum, including the ensiform appendix, has six centers: one for the manubrium, four for the gladiolus, and one for the ensiform appendix. The gladiolus becomes entirely ossified at middle life, but it rarely unites with the manubrium till a much later period.

In respect to shape the bones form four classes: the long, short, flat, and irregular. The long bones and the short together, include all the bones of the upper and lower extremities and the two clavicles. Each long bone consists of a cylinder, or shaft, and two extremities. The short bones are the bones of the wrist and ankle.

The ribs are flat and long, but are classed with the flat. The innominate are flat, and very irregular; they are also classed with the flat. The other flat bones are the occipital, frontal, parietal, nasal, lachrymal, vomer, scapula, sternum, and patella.

The irregular bones are the vertebræ, sacrum, and coccyx, the temporal, sphenoid, ethmoid, superior maxillary, malar, palate, inferior turbinated, inferior maxillary, malleus, incus, stapes, and hyoid; making 46 of the irregular, 40 flat, 30 short, and 90 long.

The long bones serve as pillars of support, and as levers for the muscles.

The flat bones serve to protect important organs beneath or within, as the bones of the cranium, thorax, and pelvis.

Of the 206 bones of the adult, 188 have muscles attached to them for support or motion.

The following have no muscles attached:—

1 Ethmoid,
1 Vomer,
2 Nasal bones,

2 Inci (plural of incus),
2 Inferior turbinated,
2 Astragali (plural of astragalus),
2 Semi-lunar,
2 Scaphoid (of the wrist),
2 Cuneiform of the wrist, and
2 Middle cuneiform of the ankle.

Total, 18

The following have **one muscle** attached : —

2 Parietal,
2 Lachrymal,
2 Stapes,
2 Trapezoid,
2 Ossa magna (plural of *os magnum*),
2 Cuboid,
2 Scaphoid.

Total, 14

Bones with **two muscles** attached : —

2 Unciform,
2 Pisiform,
2 Internal cuneiform,
2 External cuneiform,

Total, 8

Bones with **three muscles** : —

1 Frontal (three *pairs* of muscles),
2 Trapezia * (plural of trapezium),
2 Mallei (plural of malleus).

5

Bones with **four muscles** : —

2 Palate,
2 Patellæ (plural of patella),
1 Coccyx (four pairs of muscles).

Total, 5

The two malar (cheek) bones have **five muscles** attached to each.

The clavicle (collar-bone) has **six**.

The sacrum has 8 pairs of muscles, and the two heel-bones have each **eight muscles** ; the radius and fibula each **nine muscles** — *i.e.*, 2 radii and 2 fibulæ have each nine muscles attached.

The sternum has 9 pairs and one single muscle.

The hyoid bone has 11 pairs, and the 2 superior maxillary bones and 2 tibiæ have each **eleven** muscles ; the occipital and sphenoid bone each **twelve** (twelve pairs) ; the ulna of each fore-arm, **thirteen** mus-

* "A," at the end of a Latin word is pronounced like "ä" in bar.

cles; the inferior maxillary 14 pairs, and the 2 temporal bones each **fourteen** muscles; the scapula, **seventeen**; the femur of each thigh, **twenty-three**; the humerus of each arm, **twenty-five**; and each hip-bone has **thirty-six muscles** attached to it.

Besides these, all the metacarpal bones, the metatarsal, the phalanges, ribs and vertebræ have muscles attached. Nearly all the muscles are in pairs; only four are single. It may be observed that the muscles attached to *mesial* bones are *pairs* of muscles generally.

With the exception of the hyoid and the bones of the ear, all the bones articulate with each other. The hyoid does not articulate with any other bone, and the ear-bones only with each other. The ethmoid bone articulates (touches, or connects) with *thirteen* bones; the frontal and sphenoid bones articulate each with *twelve* bones; the superior maxillary with *nine;* the os magnum with *seven;* and all others with *less* than seven.

Bone is said to be composed of two kinds of tissue, compact and cancellated; but really all bone is porous, and one part is only more compact than another. The cancellated (like lattice-work) tissue is more open, or more porous. In the skull of middle life there are two tables, or plates, of compact bone, one external, the other internal; and between them is some cancellated tissue called the diploë (double). The diploë is spongy, and contains numerous blood-vessels. It might in some cases prevent the fracture of the inner table, and thus increase the degree of protection of the brain. The compact tissue of bone is generally found at the surface or outer part of the bone, and the cancellated tissue within its substance. The larger canals and passages for blood-vessels and nerves in the bones were named Haversian canals, from Clopton Havers, their early discoverer.

The small canals were called canaliculi (little canals), and are less than one ten-thousandth of an inch in diameter. The smallest canals contain a single capillary vessel; the larger contain blood-vessels, nerves, and marrow. Around each Haversian canal the osseous tissue is arranged in concentric (having one common center) lamellæ (little plates), varying in number from eight to fifteen. The lamellæ themselves consist of a delicate network of fibers, coalescing at their point of junction. In and between the little plates that surround the larger canals are minute cavities called lacunæ (little lakes, or pools), which contain the bone cell.

Besides the concentric lamellæ, there are other plates, or layers of bone, which are concentric with the medullary canal, and serve to bind together the various Haversian systems. The layers surrounding the medullary canal of the long bones are termed circumferential (bearing

around) lamellæ. Then there are rows of posts, or pillars, of support between the concentric lamellæ, and these have been called interstitial (standing between) lamellæ. The Haversian canals are lined by a delicate membrane continuous with the periosteum. The smallest canals extending from the lacunæ are filled with the fine processes of the bone cell which fills each lacuna.

The bones have many prominences and depressions, each of which is utilized, and many of which take distinctive names, as heads, condyles, sutures, tubercles, tuberosities, spines, processes, cavities, fossæ, sinuses, etc. One hundred and twenty bones have heads. The heads of the ribs articulate (connect by joint) with the bodies of the dorsal vertebræ. The head of the scapula (shoulder-blade) articulates with the head of the humerus. The latter (the humerus) has a second head at the elbow, called the radial head, which articulates with the head of the radius. The head of the ulna is at the lower extremity of the bone near the wrist, and articulates with the triangular fibro-cartilage which separates it from the wrist-joint. It also articulates with the semi-lunar, or sigmoid, cavity of the radius.

The heads of the metacarpal and metatarsal bones and phalanges lie at the opposite extremity from the base. The base of each bone is nearest the wrist or ankle, while the head is the part nearest the ends of the fingers and toes.

The base of the metacarpal and metatarsal bones and phalanges is generally concave, while the head is convex, or rounded.

The head of the astragalus is the anterior portion, and it articulates with the scaphoid bone. The head of the femur articulates with the cotyloid (cup-like) cavity of the hip. The cotyloid cavity of the hip-bone is also called the acetabulum (vinegar cruse). The head of the tibia is the upper extremity of the bone at the knee, and articulates with the condyles of the femur. The head of the fibula is, also, at the upper extremity of the bone, and articulates with the tibia near the knee, but does not form a part of the knee-joint.

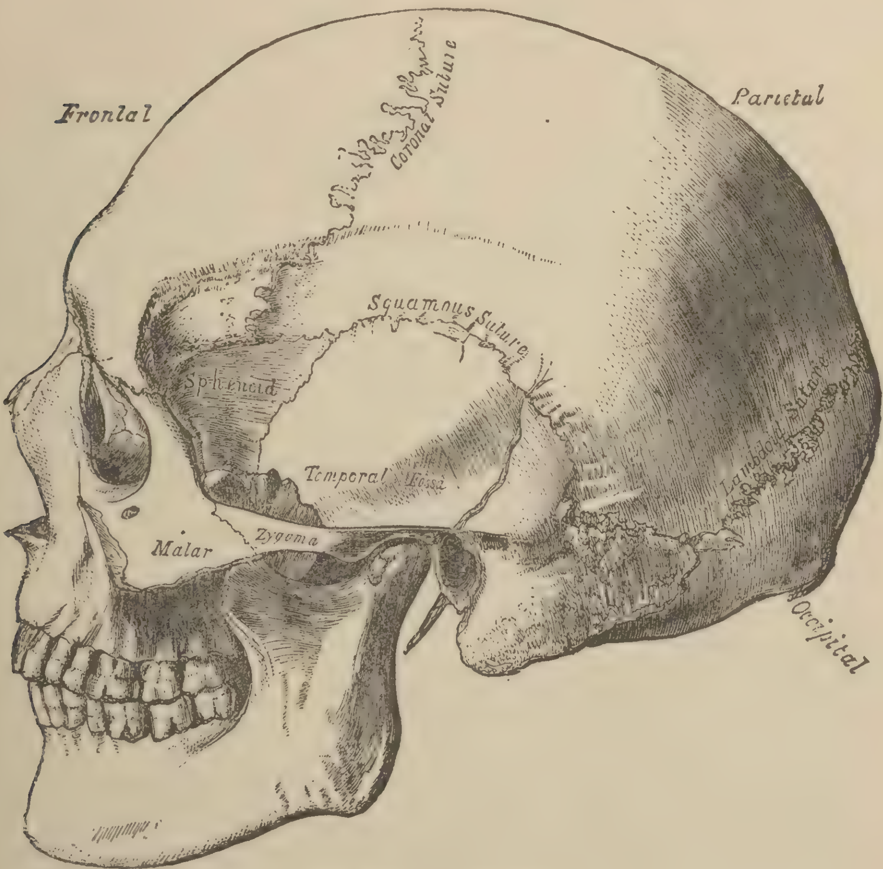
The head of the malleus is the upper extremity of the bone, and articulates posteriorly with the incus, being free at its upper part. The head of the stapes articulates with the long process of the incus.

We have now described the heads of 120 bones; viz., 56 bones that compose the phalanges, 24 ribs, 10 metacarpal, 10 metatarsal, and two each of the following: the astragalus, tibia, fibula, femur, radius, ulna, humerus, scapula, malleus, and incus. Six bones have condyles. They are the occipital bone, inferior maxillary, humerus of each arm, and the femur of each thigh. (Condyle signifies knuckle, or knot.) The two condyles of the occipital bone articulate with the cups of

the atlas. The condyle of the inferior maxillary bone, called also the condyloid process, articulates on each side of the head, with the glenoid (glen-like) fossa of the temporal bone immediately in front of the external ear-passage.

The two condyles of the humerus form the internal and external prominences of the elbow, and the two condyles of the femur articulate with the tibia at the knee.

Fig. 7.



SIDE VIEW OF THE SKULL.

The cranial and facial bones have sutures (seams); but those sutures that connect the cranial bones with those of the face, and the facial bones with each other, have received no special names. The cranial sutures are divided into *sutures at the vertex*, at the side, and at the base of the skull. Those at the vertex are the ones most

worthy of remembrance. They are the sagittal (arrow), coronal (crown), and lambdoid (like the Greek letter λ, shaped like the two contiguous sides of a triangle, which is the shape of the suture). The sagittal suture meets the coronal as the arrow meets the bow, nearly at right angles.

A small, rough eminence is called a tubercle; if broad and rough, a tuberosity. Tubercle and tuberosity are sometimes interchangeable.

The femur has two large tuberosities, which take the special names of "trochanter (wheel) major," and "trochanter minor." They serve for attachment of muscles which rotate the thigh — the word "trochanter" signifying to run round. Other prominent tuberosities are the two tuberosities of the humerus, greater and lesser, situated near the shoulder, one on either side of the bicipital groove, which lodges the long tendon of the biceps (two-headed) muscle; the tuberosity of the radius, near its head, for the attachment of the biceps muscle; the internal and external tuberosities at the head of the tibia; and the tuberosity of the ischium, which forms the lowest part of the hip-bone, on which we rest when seated.

The most prominent tubercle is the tubercle of the tibia, situated about two inches below the knee-joint, and in front of the bone for the attachment of the ligamentum patellæ (ligament of the knee-pan), which is the common tendon for the triceps (three-headed, called also quadriceps) extensor of the leg.

The most prominent spines are the spine of the scapula, spine of the pubes, spine of the ischium, and the four spines of the ilium — two anterior and two posterior.

The processes of the bones are very numerous, among which we mention here as prominent, the acromion and coracoid of the scapula (shoulder-blade); the alveolar of the maxillary bones for the teeth; the two coronoid, and the two condyloid, of the inferior maxillary (lower jaw); the coronoid process of each ulna, making four coronoid processes; the two jugular processes of the occipital bone; the two mastoid of the temporal bones; the odontoid process of the axis; the olecranon process of each ulna; the palate process of the palate bone; the two pterygoid processes of the sphenoid bone; the spinous processes of the vertebræ; the styloid process of each radius, of each temporal, and of each ulna, making six styloid processes; the transverse processes of the vertebraæ; and the zygomatic processes of the temporal and malar bones, which together form on each side of the head the zygomatic arch.

The prominent cavities of single bones are the cotyloid cavity of the hip, the glenoid of the scapula, and temporal bone, and the sigmoid

cavity of the radius and ulna. The ulna has a greater and a lesser sigmoid cavity. The most prominent fossæ (cavities whose entrance is larger than the base) are the glenoid fossa, or cavity, of the temporal bone; the iliac fossa of the ilium; the infra-spinous, and the supra-spinous, of the scapula; the lachrymal (tear), for the lachrymal gland; the anterior, middle, and posterior fossæ (cavities) of the base of the cranium (skull), for the three corresponding lobes (anterior, middle, and posterior lobes) of the brain; the subscapular (under the shoulder-blade), on the anterior or inner side of the scapula, for the subscapularis muscle; the temporal fossa, formed by aid of five bones, for the temporal muscle; and the zygomatic fossa, situated below, and on the inner side of the zygomatic arch. The zygomatic arch, or zygoma (yoke), is formed by the union of the zygomatic processes of the temporal and mala (cheek) bones, and the zygomatic fossa contains the lower part of the temporal muscle, the pterygoid muscles, the internal maxillary artery, and the inferior maxillary nerve. The term "sinus" (a hiding-place, pocket, bay, or gulf) has in medicine three different significations, and has been applied, first, to parts of the nasal cavities; second, to channels, or canals, for venous blood in the encephalon (within the head), and gravid uterus; and, third, to an abnormal passage leading from a deep-seated abscess, or diseased bone. The term is also applied to the depressions, or cavities, in the walls of the vessel behind the valves at the commencement of the pulmonary artery and aorta, and to a depression in the prostatic portion of the urethra (passage from the bladder); but these are comparatively unimportant. The sinuses of the nasal cavities are the *maxillary*, sometimes called the antrum (cave) of Highmore, the *frontal*, the *sphenoidal*, and the *ethmoidal* (or ethmoid cells). The sinuses of the pulmonary artery and aorta are called the sinuses of Valsalva.

The term crista galli (comb of a cock) is the name of a process rising above the cribriform (sieve-like) plate of the ethmoid bone, for the attachment of the falx cerebri (scythe of the cerebrum) in front. The falx cerebri is a membrane which divides in part the upper brain. The "crest of the ilium" is the superior margin of the ilium — the highest part of the hip; the "crest of the tibia" is the anterior sharp edge, called, also, the shin; and the "crest of the pubis" is the edge which forms the upper surface of the bone.

One important fissure, the Glaserian, or gleniod fissure, should be mentioned in connection with the bones. It is a narrow slit in the glenoid fossa of the temporal bone, and leads into the tympanum, or middle ear.

The names, or epithets, applied to the various processes signify

objects which they resemble. Four processes of the sphenoid are called "clinoid" (like a bed), because they resemble, in situation, the four posts of a bedstead before and behind the Sella Turcica (Turk's seat, or saddle).

The coracoid (raven-like) process of the scapula was named by Galen, from its resemblance to a raven's beak.

Processes having a smooth surface for articulation with other bones are called articulating processes.

The termination "oid" signifies "like," or resembling; and we have pterygoid (like a wing), odontoid (like a tooth), mastoid (like a nipple), coronoid (crow-like), styloid (like a pencil), cotyloid (like a cup), glenoid (glen-like), etc.

A sinus differs from a fossa in having its interior more expanded than the entrance.

A foramen is an opening that pierces the bone entirely, or enters deeply into its substance. It is an opening through a bone,—a perforation. The plural is foramina. The sphenoid bone has five pairs of foramina, and sometimes six. The foramina of bones are numerous.

A canal is a channel for the passage of a liquid, blood-vessels, or nerves.

Prominent among the canals in the bones are the inferior dental canals (one on each side of the head), on the inner surface of the ramus (branch) of the lower jaw, which transmit blood-vessels and nerves to the lower teeth; the carotid canals in the petrous portion of the temporal bones, which transmit the internal carotid arteries to the brain; the lachrymal (tear) canals, called also nasal canals, or nasal ducts, which convey the tears into the inferior meatus (passage) of the nose; the semi-circular canals of the internal ear; and the spinal, or vertebral, canal for the spinal cord.

An epiphysis (growing upon) is a portion of bone, separated from the body of the bone by cartilage, which, in process of time, becomes converted into bone. The epiphysis of a bone is formed by a separate center of ossification. The diaphysis (growing through) is the main, or middle, portion of bone between the epiphyses (plural of epiphysis). In the long bones the diaphysis is the shaft, or middle portion, to which the epiphyses later in life become attached. At birth the epiphyses of all cylindrical bones, with the exception of the lower epiphysis of the femur, and occasionally the upper epiphysis of the tibia, are still unossified.

The bones of the wrist (carpal bones) are all cartilaginous at birth. The pisiform (peaform) appears latest of the carpal bones, at about the twelfth year. The epiphyses of the bones of the hand and foot appear

about the third to the seventh year, and become completely ossified and united to the diaphyses about the twentieth year. The head of the humerus, at the shoulder, begins to ossify about the second year, and unites with the shaft about the twentieth year. The epiphyses at the elbow become united somewhat earlier,—about the eighteenth year. The femur is developed in about the same time with the humerus; but the head of the femur is joined to the shaft about two years sooner than the condyles at the knee. The condyles at the knee unite with the femur about the twentieth year.

The vetebræ are not completely formed till about the thirtieth year of life.

The words superior, inferior, anterior, posterior, above, and below, have reference, in anatomy, to the position of the parts in the erect posture of the body.

THE INFERIOR MAXILLARY (Lower Jaw).

This is the largest bone of the face. It is sometimes called the mandible (from mandere to chew). It is the only bone that moves during mastication. It has a body and two rami (branches). The body is curved like a horseshoe, and is nearly horizontal; while the rami are straight, and nearly vertical. The fore part of the body is called the chin, mentum, or genium. The latter term signifies taste, or appetite. The vertical line at the middle of the chin is called the symphysis menti (union of the chin, the part where the two halves unite. The union occurs during infancy). At the lower part of the symphysis is a triangular eminence, which is called the mental process. The word mentum (chin) has the same root as mens (mind); and some regard a prominent chin as evidence of intellectual endowment. On the external surface of the body of the jaw, and just below the root of the second bicuspid tooth, on either side, is the mental foramen, where the mental nerves and vessels emerge from the bone.

These two foramina (one on each side of the median line) are about five centimeters (a little less than two inches) apart.

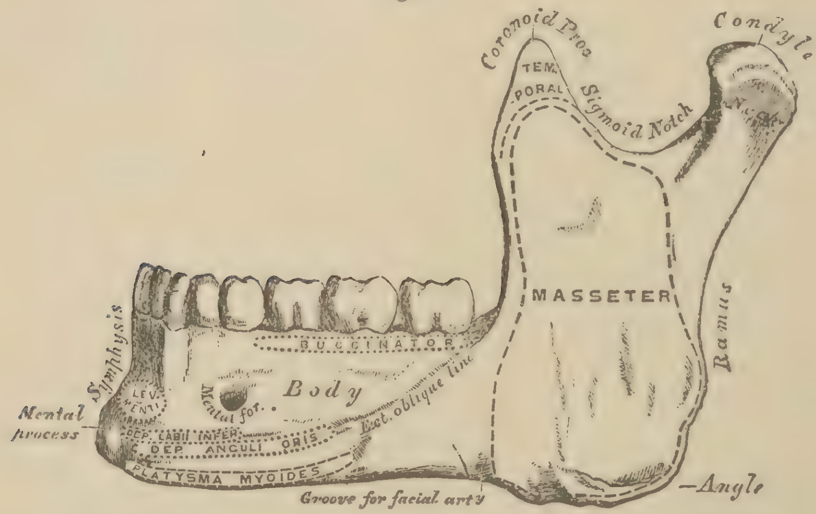
On the lower border of the body, just where it joins the ramus, is, *usually*, a shallow groove, sometimes scarcely perceptible, over which passes the facial artery, one of the branches of the external carotid.

The upper border of the body contains the alveoli (plural of alveolus), or sockets, for the teeth. In the adult there are sixteen, eight on each side of the symphysis, for the permanent teeth; in the child of three to six years there are only ten alveoli, and these contain the primary teeth.

The ramus (branch) is thinner than the body of the bone. Its posterior border meets the lower border of the body, and forms the angle of the jaw. The external surface of the ramus is nearly flat, and gives attachment to the masseter muscle. On the middle of the internal surface of the ramus is the entrance to the inferior dental canal for nerves and vessels to the lower teeth.

Each ramus is surmounted by two processes, the coronoid, and the condyle. The coronoid is thin and pointed, and gives attachment to the temporal muscle. It is separated from the condyle behind by the

Fig. 8.



THE LOWER JAW.

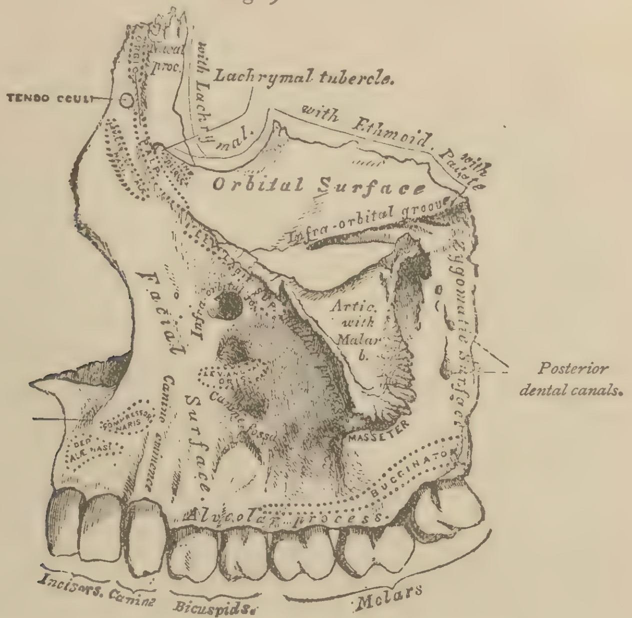
(The dotted lines indicate spaces and position for the attachment of the muscles named.)

sigmoid notch. The condyle articulates with the temporal bone in the glenoid (glen-like) fossa. The lower jaw gives attachment to fourteen pairs of muscles; and if we reckon the orbicularis oris, which has a few fibers from this bone, and is a single muscle, we shall have in all twenty-nine muscles. Great changes take place in the lower jaw from infancy to old age. Before the teeth appear in infancy, and after their loss in old age, the angle is more obtuse than in middle life. After the loss of the teeth the bone becomes reduced in size, by the absorption or removal of the alveolar process, so that only the basilar, or lower, part of the bone remains. It is developed at an early period of embryonic life, ossification commencing in this bone and the clavicle about the sixth or seventh week.

THE SUPERIOR MAXILLARY BONE.

This bone unites with its fellow of the opposite side to form the upper jaw. Of all the facial bones it is second in size, the lower jaw being largest. It extends vertically from the frontal bone above, along the side of the nose to the lower margin of the alveolar process, which contains the upper teeth. Each bone helps to form the roof of the mouth, the floor and outer wall of the nose, and the floor of the orbit for the eye.

Fig. 9.



LEFT SUPERIOR MAXILLARY BONE—OUTER SURFACE.

It has four processes; the nasal (nose), malar (cheek), palate (roof of the mouth), and alveolar (socket process). The latter contains the upper teeth.

The palate process forms a part of the roof of the mouth, and separates, anteriorly, the cavities of the mouth and nose; the nasal process runs upward, and forms, in part, the side of the nose; and the malar process articulates with the malar bone, and helps to form the cheek.

It has also four surfaces, and if we reckon the roof of the mouth, *five*. The four usually given are the facial, the posterior, or zygomatic, the superior, or orbital, and the internal. The latter (the internal surface) is divided by the palate process into *two* surfaces, one of which forms part of the roof of the mouth, and the other a part of the nasal

fossa (or cavity). The zygomatic surface (See Fig. 9), along the alveolar process, is continuous with the facial surface, but is separated above from the facial surface by the malar process. The zygomatic surface, although convex, forms part of the zygomatic fossa (cavity). On this surface, which looks backward and outward, are the apertures of the posterior dental canals, which transmit to the teeth the posterior dental nerves and vessels. On the inner margin of this surface is the

Fig. 10.

LEFT SUPERIOR MAXILLARY BONE — INNER SURFACE.

entrance to a groove, which forms in part the posterior palatine canal. (See Fig. 10.) This groove is converted into a canal by the palate-bone. It transmits nerves and vessels to the soft palate and roof of the mouth.

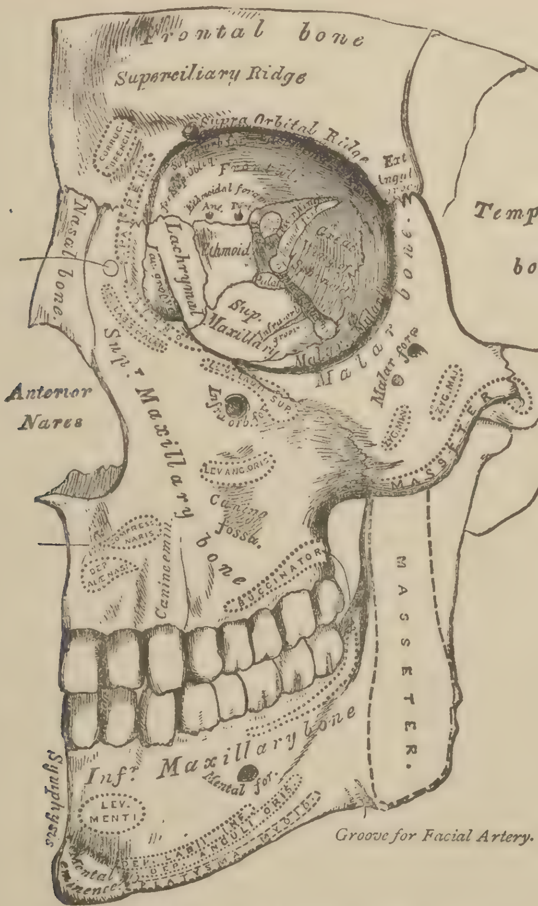
The anterior palatine canal is nearly parallel with the posterior. Both run obliquely downward and forward, and both transmit nerves and vessels to the palate (roof of the mouth). The anterior palatine canal opens from the nasal fossa into the mouth close to the median line, and just behind the upper incisors (front teeth). It transmits the *naso-palatine* nerve. Its position is indicated in the figure by bristle.

The facial surface of the superior maxillary bone looks forward and outward, and forms part of the face. Its prominent features are: the nasal notch, for the anterior nostril; the incisive fossa, just above the two upper front teeth; the canine fossa, separated from the incisive by

the canine eminence; and the infra-orbital foramen (opening beneath the orbit), which is the termination of the infra-orbital canal. (See Fig. 9.)

The canine (dog) eminence lies in front of the socket of the canine tooth (the dog-tooth, or cuspid). The incisive fossa gives origin to

Fig. 11.



BONES OF THE FACE—LEFT SIDE.

the depressor alæ nasi (depressor of the wing of the nose); and the canine fossa to the levator anguli oris (lifter of the angle of the mouth). The infra-orbital (beneath the orbit) canal is sometimes only a groove in the floor of the orbit, but commonly it runs along just beneath the floor of the orbit, commencing at the upper margin of the zygomatic

surface, behind the floor of the orbit. It transmits the infra-orbital nerve and vessels.

The infra-orbital canal divides near its middle part, and forms a second canal — the anterior dental canal. The latter may be described as leading from the infra-orbital canal to the upper front teeth. Its entrance is usually concealed from view by the orbital surface of the bone. It transmits the anterior dental nerve, one of the branches of the superior maxillary.

The orbital surface of the superior maxillary forms the greater part of the floor of the orbit. Its inner margin articulates with three other bones. These are the lachrymal in front, the "os planum" (smooth bone) of the ethmoid in the middle, and the orbital process of the palate bone behind.

The internal surface of the superior maxillary bone assists largely in forming the cavities of the mouth and nose. A large cavity — the maxillary sinus — is found beneath the floor of the orbit which communicates with the middle meatus of the nose. This cavity is separated from the orbit by a very thin plate of bone. It is often called the antrum (cave) of Highmore, its supposed discoverer, although Casserius previously mentioned it under the name of antrum genæ (cave of the cheek, or cheek cavity). In some cases the floor of the antrum is pierced by the roots of the first and second molar teeth. Crossing the antrum ("cave"—the maxillary sinus) is one or more projecting laminæ (plates) of bone, which serve to strengthen the bone at this part. The cells above these laminæ are closed in by the ethmoid and lachrymal bones. The superior maxillary sinus varies greatly in size and shape. In the middle part of the upper portion (the nasal portion) of the internal surface is a deep groove, formed in part by the nasal process of this bone. This groove is converted into a canal by the lachrymal and inferior turbinated bones, and lodges the nasal duct, which conveys the tears from the eye into the inferior meatus of the nose.

The superior maxillary articulates with nine bones, and gives attachment to eleven muscles. Each superior maxillary articulates with its fellow of the opposite side, and with eight other bones: these are the frontal, ethmoid, vomer, nasal, lachrymal, malar, palate, and inferior turbinated.

THE INFERIOR TURBINATED BONES.

These bones, two in number, extend horizontally, on either side, along the outer wall of the nasal fossa. Each bone is curled upon

Fig. 12.

RIGHT INFERIOR TURBINATED BONE — INTERNAL SURFACE.

itself, its internal surface convex, and its external surface concave. The upper border is connected to various bones (palate, ethmoid, lachrymal, and superior maxillary) along the outer wall of the nose.

Fig. 13.

RIGHT INFERIOR TURBINATED BONE — OUTER SURFACE.

The lower border is free, and is a little more than one centimeter (about one half inch) above the floor of the nose. This bone divides the middle meatus (passage) from the inferior meatus of the nose. Authors describe three processes — the ethmoidal, lachrymal, and maxillary. It articulates with four bones, as given above.

The middle and **superior turbinated bones** are properly *parts of the ethmoid.*

THE VOMER (Ploughshare).

This bone forms the lower and back part of the septum (partition) of the nose. It is often bent, or deflected to one side.

The septum is completed in front by the triangular cartilage below and the perpendicular plate of the ethmoid above. In position the vomer is vertical, and extends backward and upward to the body of the

sphenoid. It rests below, in the median line, upon the roof of the mouth, or, more properly, upon the palate processes of the superior maxillary and palate bones; thus articulating with two pairs of bones

Fig. 14.

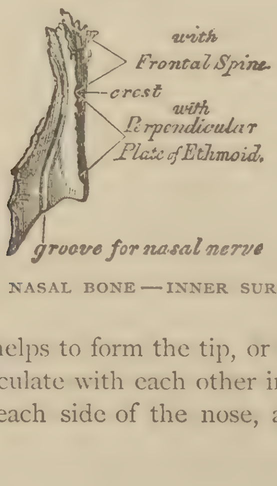
THE VOMER.

and two single bones. It has no muscles attached. Its posterior border is free, and separates the apertures of the posterior nares (nostrils opening from the throat, or pharynx).

THE NASAL BONES.

The nasal bones, one on each side of the median line, form the bridge of the nose. They extend from the frontal bone above to the

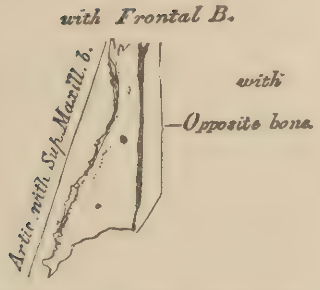
Fig. 15.



LEFT NASAL BONE—INNER SURFACE.

lateral cartilage, which helps to form the tip, or base, of the nose, below. Their inner borders articulate with each other in the median line; their outer borders, one on each side of the nose, articulate with the nasal

Fig. 16.



RIGHT NASAL BONE — OUTER SURFACE.

process of the superior maxillary (upper jaw) bone, which also forms part of the side of the nose. They also articulate, at the internal border, with the perpendicular plate of the ethmoid.

THE LACHRYMAL (Tear) Bones.

These two bones, one on either side, are the smallest of the face. They resemble in form and size the finger-nail, and are placed at the anterior and inner part of the orbit. They convert the nasal grooves of the superior maxillary bones into canals for the nasal ducts. Each bone is a thin scale, and, from its form and size, is sometimes called the

Fig. 17.

LEFT LACHRYMAL BONE — EXTERNAL SURFACE.

os unguis (finger-nail bone). It affords attachment to one muscle,—the tensor tarsi,—sometimes called the muscle of Horner. The muscle

is .6 cent. (¼ inch) broad and 1.3 cent. (½ inch) long. It divides into two parts at the commissure of the lids, and is inserted into the tarsal cartilages of the eyelids.

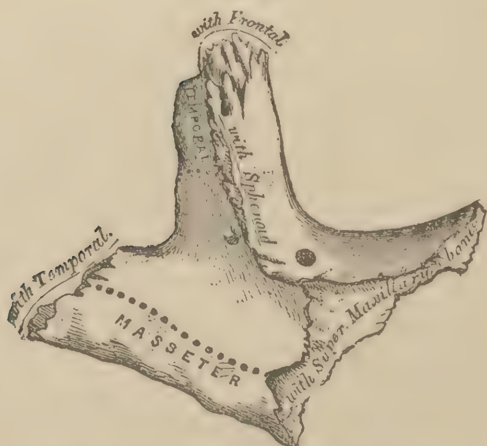
THE MALAR BONES.

The malar (apple) bones, one on each side, are the cheek-bones,—so named from the roundness of the cheeks. They help to form the outer wall and floor of the orbit and part of the temporal and zygomatic fossæ. The malar bone, on each side, divides the orbit from the temporal fossa, as may be seen by reference to the cranium. It has three

Fig. 18.

LEFT MALAR BONE — OUTER SURFACE.

Fig. 19.



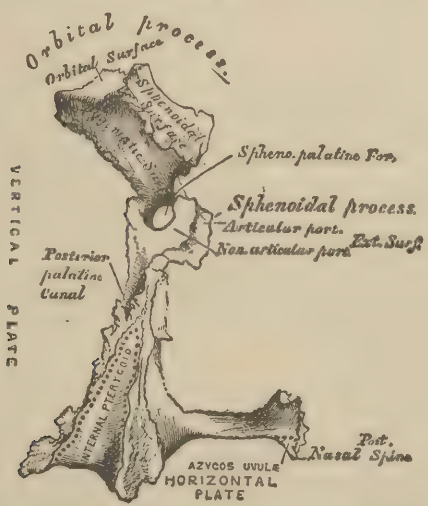
LEFT MALAR BONE — INNER SURFACE.

processes: the orbital, frontal, and zygomatic. The latter meets the zygomatic process of the temporal bone to complete the zygomatic arch. It articulates with four bones, and gives attachment to five muscles. Two of the muscles, the zygomatic major and minor, are inserted into the angle of the mouth and upper lip.

THE PALATE BONES.

The palate bones take their name from the fact that they form part of the palate (roof of the mouth). They also form the posterior portion of the floor of the nose, part of the floor of the orbit, and the inner wall of the antrum (maxillary sinus). Each bone has a palate process, a vertical plate, and an orbital process. The palate process separates, in part, the mouth and nose. It is sometimes called the horizontal plate. Its posterior border affords attachment for the velum palati (veil, or cover, of the palate), often called the soft palate. The vertical

Fig. 20.



LEFT PALATE BONE—POSTERIOR VIEW.

plate runs upward from the palate process to the orbital, along the inner wall of the antrum. It has a groove, which assists in forming the posterior palatine canal. The orbital process forms a portion of the floor of the orbit. The palate bone articulates with six bones and gives attachment to five muscles. The muscles are the internal and external pterygoid, the superior constrictor of the pharynx, the tensor palati, and the azygos uvulæ.

Fig. 21.

LEFT PALATE BONE — INTERNAL VIEW.

THE ETHMOID.

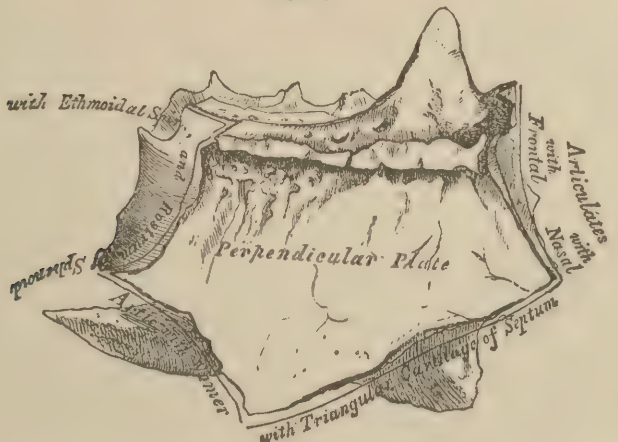
The ethmoid (sieve-like) bone is the most delicate bone in the body. It is situated at the anterior part of the base of the cranium, between the two orbits at the root of the nose. It consists of the horizontal, or cribriform (sieve-form), plate, the perpendicular plate, and the two lateral

Fig. 22.

ETHMOID BONE — UPPER AND RIGHT SIDES (ENLARGED).

masses. The horizontal plate forms part of the base of the skull, and lies in the ethmoid notch of the frontal bone, between the orbital plates. This part of the bone, the horizontal or cribriform plate, is perforated by several minute foramina, which transmit the olfactory nerves. From these perforations the bone itself and the cribriform plate both take their names. At the middle line of the cribriform, or horizontal plate, is a projection — the crista galli (comb of a cock) — for the attachment of the falx cerebri (sickle, or scythe, of the brain). The latter is a fold, or process, of the dura mater (hard mother), which separates and sup-

Fig. 23.



ETHMOID BONE — VERTICAL SECTION IN THE MEDIAN LINE (ENLARGED).

ports the two lateral halves of the upper brain. The perpendicular plate of the ethmoid forms a considerable part of the septum (partition) of the nose.

The lateral masses of the ethmoid form the inner walls of the orbits, and contain the anterior and posterior ethmoidal cells, which form parts of the nasal cavities. The anterior ethmoidal cells communicate with the middle meatus of the nose, while the posterior ethmoidal cells communicate with the superior meatus of the nose. The anterior ethmoidal cells also communicate in the adult with the frontal sinuses.

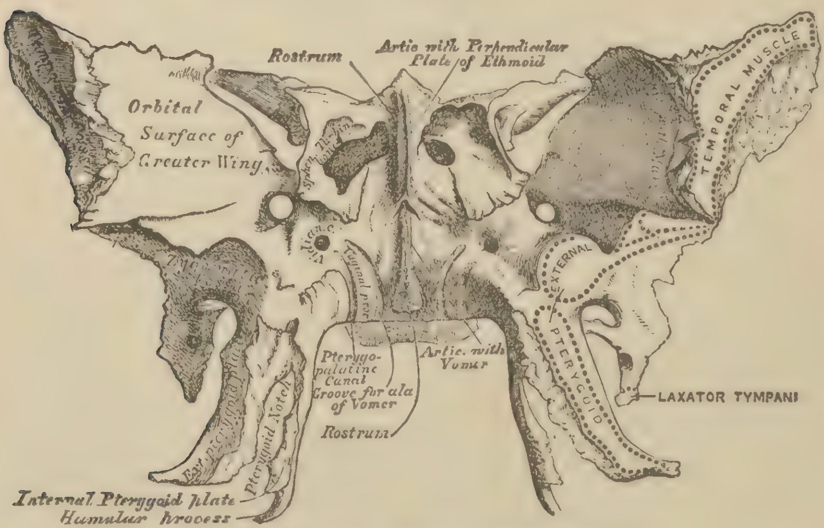
The outer smooth surface of each lateral mass, which forms the inner wall of each orbit, is called the "os planum" (smooth, or level bone). The ethmoid articulates with thirteen bones (sometimes fifteen), all the bones of the face except the malar and lower jaw, and two of the skull,— sphenoid and frontal. The two "sphenoidal turbinated bones" are usually, in the adult, joined to the body of the sphenoid bone, but are sometimes separate, in which case the ethmoid articulates with fifteen bones. The two sphenoidal turbinated bones are called also "sphenoidal spongy bones."

THE SPHENOID.

The sphenoid (wedge-like) bone is situated at the anterior part of the base of the skull, and extends outward on either side to the temple. It assists in forming the cavity of the cranium (skull), the two orbits, the two nasal fossæ (cavities of the nose), the two temporal fossæ, the two zygomatic fossæ, the two spheno-maxillary fossæ, the two pterygoid fossæ, the two sphenoidal fissures, the two spheno-maxillary fissures, and the two pterygo-maxillary fissures.

The sphenoidal fissure is the "foramen lacerum anterius" (anterior lacerated opening) of Gray, and the "foramen lacerum superius" (superior lacerated opening) of Dunglison. It opens into the orbit between the greater and lesser wings of the sphenoid, and transmits several

Fig. 24.



SPHENOID BONE—ANTERIOR SURFACE.

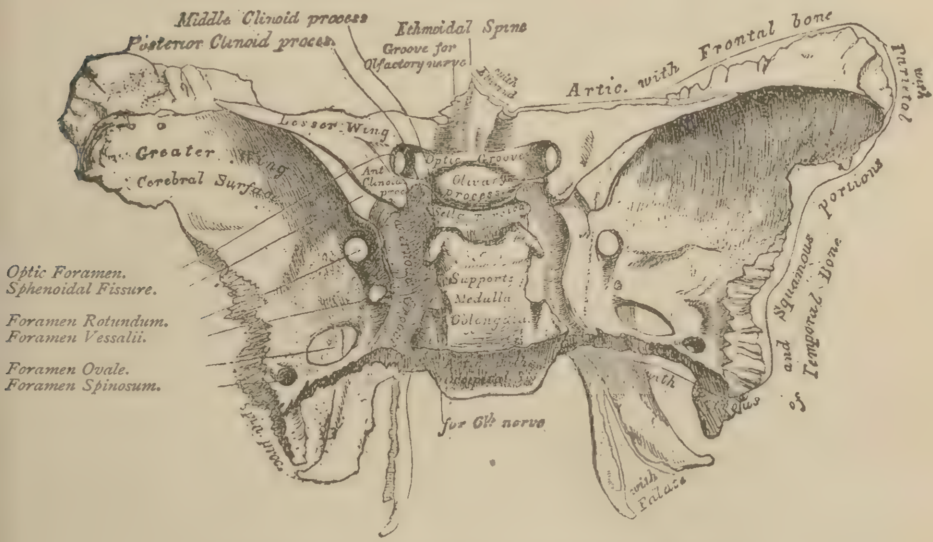
pairs of cranial nerves. The spheno-maxillary fissure also opens into the orbit, and forms a communication between the orbit and three fossæ, —the temporal, zygomatic, and spheno-maxillary.

The sphenoid articulates with all the remaining bones of the cranium, and with five of the face (the two malar, the two palate, and the vomer). It has a body, two greater wings, two lesser wings, and two wing-like (pterygoid) processes. Besides the sphenoidal fissure and one canal,—the Vidian,—there are on either side four, and sometimes five, other foramina, which perforate the sphenoid bone. The remaining

four are the "optic," for the optic nerve and ophthalmic artery; the foramen rotundum (round opening) for the superior maxillary nerve (second division of the fifth cranial); the foramen ovale (oval opening), for the inferior maxillary nerve (third division, or branch, of the fifth cranial); and the foramen spinosum, for blood-vessels and filaments of the sympathetic system of nerves. The Vidian canal, which passes through the body of the sphenoid at the root of the pterygoid process, transmits the Vidian nerve, which supplies a part of the septum (partition) of the nose, and divides into two branches — the large petrosal and carotid branches.

In the body of the sphenoid are two large, irregular, and unsymmetrical cavities, called the sphenoidal sinuses, which communicate with the

Fig. 25.



SPHENOID BONE — SUPERIOR, OR CEREBRAL SURFACE.

superior meatus of the nose. The sphenoid gives attachment to twelve pairs of muscles. These include all the muscles of the orbit except the inferior oblique; three muscles of mastication, viz., the temporal, external, and internal pterygoid; two muscles of deglutition, viz., the tensor palati and the superior constrictor of the pharynx, and the laxator tympani of the middle ear.

The other points of the sphenoid which should be mentioned are the *optic groove*, which supports the commissure of the optic nerves; the *olivary process*, just behind the groove; the *sella Turcica* (Turk's seat,

or saddle), a deep and smooth cavity on the upper surface of the body of the bone, which lodges the pituitary body of the brain; the anterior and posterior *clinoid* (bed-like) *processes*, situated like four bed-posts around the sella Turcica; the *rostrum* of the sphenoid, received into a depression in the vomer; the *spine*, or spinous process, of the sphenoid at the lower part of the external surface of the greater wing, which gives attachment to the external lateral ligament of the jaw, and laxator tympani (loosener of the drum) muscle; the *orbital surface* of the greater wing, assisting to form the outer wall of the orbit; and the internal and external *pterygoid plates* of the pterygoid processes, which unite partially in front, on either side, and form the *pterygoid fossæ*. The external pterygoid (wing-like) plate on either side gives attachment, by its outer and anterior surface, to the lower head of the external pterygoid muscle, and by its inner surface, which forms part of the pterygoid fossa, to the internal pterygoid muscle. The internal pterygoid plate is narrower and longer, and curves outward at its extremity in a hook-like (hamular) process, around which turns the tendon of the tensor palati (stretcher, or tightener, of the palate—the soft palate, or veil of the palate) muscle. The anterior surface of the pterygoid process forms the posterior wall of the spheno-maxillary (sphenoid bone and upper jaw) fossa, and supports Meckel's (John Frederick Meckel) ganglion.

THE TEMPORAL BONES.

The temporal (signifying "time," because the first gray hairs usually appear in this region) bone is situated on either side of the head around, and mostly above, the external ear-passage. It derives importance from the fact that it contains the organ of hearing. Each bone consists of *three portions:* the squamous (scaly), mastoid (nipple-like), and petrous (rocky).

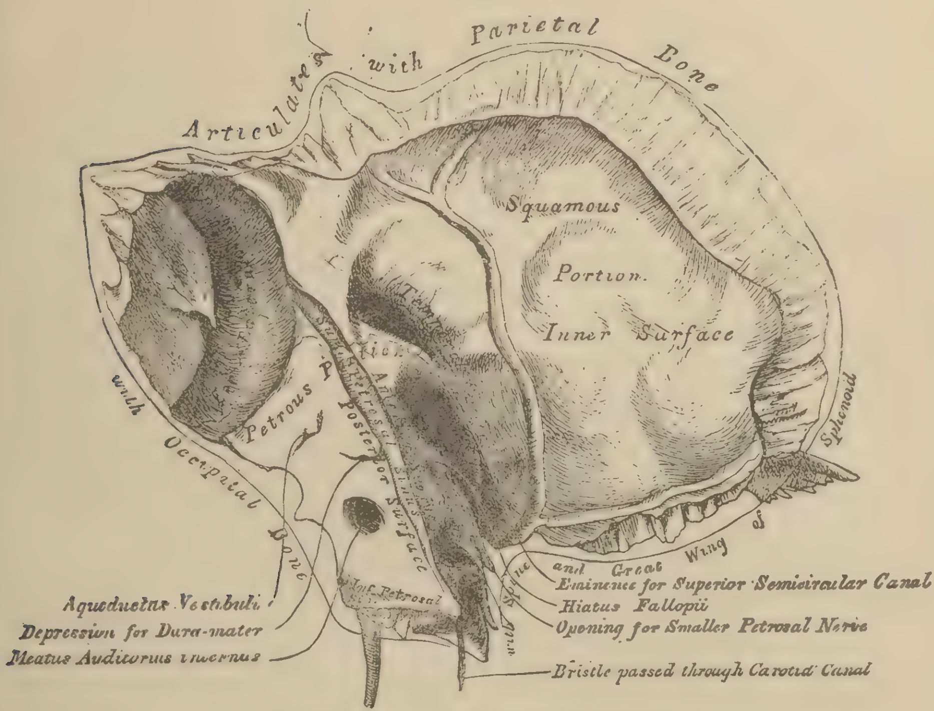
The squamous and mastoid portions form part of the outer wall of the cranium; but the petrous portion extends inward, and forms a part of the base of the cranium.

The squamous portion is the upper part; is thin and tranlucent, and articulates with the parietal bone, forming the squamous suture. Its outer surface forms part of the temporal fossa; its inner surface is continuous with the upper surface of the petrous portion.

Projecting from the outer surface of the squamous portion, near its base, is a long curved process, called the zygomatic (yoke) process. This process extends forward, and unites with the malar bone to form the zygomatic arch beneath which plays the temporal muscle. The

zygomatic process is connected to the temporal bone by three roots, although only one is discoverable when viewing it from above. Dunglison mentions only two roots of the zygomatic process. The middle root, together with the auditory process, separates the glenoid (glen-like) fossa from the external ear-passage. The auditory process is a curved plate of bone, surrounding the lower part of the circumference of the external ear-passage, and to which is attached the cartilage of

Fig. 26.



LEFT TEMPORAL BONE — INNER SURFACE.

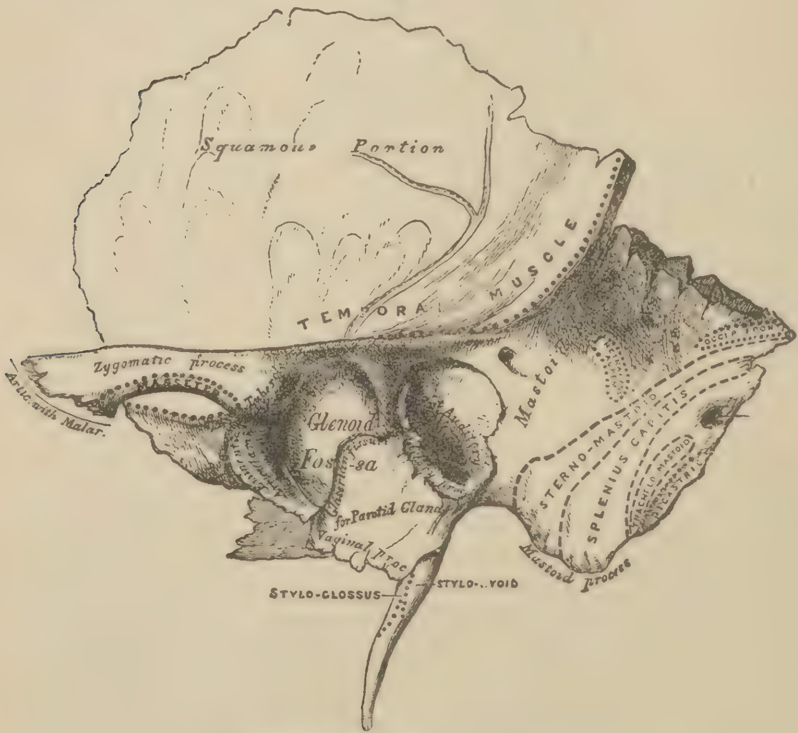
the external ear (the pinna). The superior border of the zygomatic process gives attachment to the temporal fascia (band or bandage). The inferior border and inner surface of the process gives attachment to the masseter (chewing) muscle. The latter extends to the angle of the lower jaw.

The glenoid fossa is situated one or two centimeters (half an inch) in front of the external ear-passage, and between the anterior and middle roots of the zygomatic process. It is divided by the Glaserian fissure into two parts. The anterior part is occupied by the condyle of the lower jaw; the posterior lodges a portion of the parotid (near the ear) gland.

The Glaserian fissure leads into the tympanum, or middle ear, and transmits the tympanic artery and a very small muscle—the laxator tympani (loosener of the drum; more properly of the membrane, or head of the drum).

The squamous portion of the temporal bone articulates in front, by a serrated (saw-tooth) edge, with the great wing of the sphenoid, and below, with the lower jaw. The mastoid portion is situated at the back part of the bone, behind and beneath the squamous portion, and

Fig. 27.



LEFT TEMPORAL BONE—OUTER SURFACE.

behind the external ear-passage. This portion of the bone takes its name from a large conical projection at its outer and lower part, called the mastoid (nipple-like) process. It forms the prominence just behind the ear, and contains at puberty the mastoid cells that open by one or two orifices into the middle ear, or tympanum. It also gives attachment to several muscles, one of which, the sterno-mastoid (also called sterno-cleido-mastoid), becomes prominent in the neck when the head is turned toward the opposite side. On the inner and posterior

side of the mastoid process are two grooves,—a deeper external one, and a shallow and more internal one,—for the attachment respectively of the digastric (two-bellied) muscle and for the bed of the occipital artery.

On the inner surface of the mastoid portion is a deep groove, for the lateral sinus, and a foramen, which transmits a vein to the sinus.

The foramen varies in size and position, but being generally found in the mastoid portion of the temporal bone, it is called the mastoid foramen. The mastoid portion articulates above with the parietal bone, and below with the occipital.

The petrous portion (pars petrosa) of the temporal bone, named from its density and hardness, is in the form of a truncated pyramid, lying upon its side, and wedged in at the base of the skull between the sphenoid and occipital bones. Its imperfect apex, rough and uneven, is received into the angular interval between the spinous process of the sphenoid and the basilar process of the occipital bone, and forms the posterior and outer boundary of the foramen lacerum medium (middle lacerated opening). The latter is closed by cartilage, and forms a kind of fontanel (little fountain) at the base of the brain. There are at the base of the brain three pairs of these lacerated foramina. They are designated by Gray, anterior, middle, and posterior; and by Dunglison, superior, anterior, and posterior. The anterior of Gray is the superior of Dunglison, and is called also the *sphenoidal fissure*, from its position between the wings of the sphenoid. The latter, sphenoidal fissure, is the better term, and avoids confusion. The middle lacerated foramen is in close connection with the carotid canal, and, being closed by cartilage, is less frequently mentioned. The posterior lacerated foramen (foramen lacerum posterius) is called, also, the jugular foramen, because it transmits the internal jugular vein in connection with the eighth pair of cranial nerves.

The petrous portion of the temporal bone projects inward and forward, and contains, in its interior, the essential parts of the organ of hearing. The external ear-passage (meatus auditorius externus) enters the base of the pyramid formed by this portion of the bone. The internal ear-passage (meatus auditorius internus) is on the posterior surface of the petrous portion near the apex of the pyramid. On the upper (or anterior) surface is an eminence which covers the superior semi-circular canal of the internal ear. In front of the eminence are one or two grooves, and also an opening (hiatus Fallopii) for the petrosal (rocky) branch of the Vidian nerve.

Near the apex of the pyramid, but external to it, is the termination of the carotid canal for the internal carotid artery. This canal is sinu-

ous, turning almost a right angle in this portion of bone. As the artery enters the canal it ascends, but quickly turns forward. As we look into the canal at its termination, we see from the front two other canals; one quite small (the canal of Huguier), for the tensor tympani muscle (stretcher or tightener of the drum) and chorda tympani (cord of the drum) nerve, and a larger one for the Eustachian tube. The chorda tympani passes in at the canal of Huguier, across the tympanum and out at the stylo-mastoid foramen. These canals both lead to the middle ear. The small canal (of Huguier) for the nerve and muscle of the drum, lies on the inner and upper side of the canal for the Eustachian tube.

The posterior surface of the pyramid, formed by the petrous portion, is continuous with the inner surface of the mastoid portion of the bone. The most prominent feature of the posterior surface is the large orifice opening into the internal ear-passage, for the auditory and facial nerves and auditory artery. The internal ear-passage is a short canal, and runs directly outward. The end of the canal is closed by a vertical plate, which is perforated by minute openings for filaments, or branches of the nerves and vessels.

The inferior surface, rough and irregular, presents the opening of the carotid canal (already mentioned, as its termination is at the upper surface, or in front of it); a large, smooth depression — the jugular fossa — for the internal jugular vein; the styloid process, — a long, sharp spine, of variable size and shape, — for the attachment of three muscles and two ligaments; and three or four small foramina, for blood-vessels and nerves. The stylo-mastoid foramen at the base of the styloid process transmits the facial and chorda tympani nerves.

This foramen derives some importance from the fact that the principal nerve which it transmits controls all the muscles of the face, fifty-three in number, and other parts besides. The course of the facial nerve from the internal ear-passage through the petrous portion of the temporal bone to the stylo-mastoid foramen is curved, and the curved canal is improperly called the "aquæductus Fallopii" (water-canal of Fallopius). *Facial canal* would be a better name. The foramina for Arnold's and Jacobson's nerves are near the jugula fossa, but are almost too small to be noticed. Arnold's nerve is the auricular branch of the pneumogastric, and Jacobson's is the tympanic branch of the glosso-pharyngeal.

The petrous portion of the temporal bone articulates with the occipital and sphenoid bones. It also contains within the tympanum three small bones, which are described with the ear.

The entire temporal bone articulates with five bones, and gives

attachment to fourteen muscles. It has in all fourteen foramina that have been described. For convenience of reference we give a list of their names and uses. On the outer surface we have the external ear-passage (meatus auditorius externus), that receives vibrations of air, and conducts them to the membrane that closes it; the mastoid foramen,—not constant,—for a vein; the auricular fissure in front of the mastoid process, for the auricular branch of the pneumogastric nerve; and the Glaserian (of Glaser) fissure, for the laxator tympani muscle and tympanic branch of the internal maxillary artery. On the inner surface we have the internal ear-passage (meatus auditorius internus), for the facial and auditory nerves; the hiatus Fallopii, for the petrosal branch of the Vidian nerve; a smaller opening external to the latter for the smaller petrosal nerve; and a small slit near the central part of the posterior surface of the petrous portion, almost hidden by a thin plate of bone, that transmits, through the aquæductus Vestibuli, a small artery and vein to the vestibule of the internal ear. On the inferior surface we have the carotid canal, for the internal carotid artery; the stylo-mastoid foramen, for the facial nerve and chorda tympani nerve; a canal for Jacobson's nerve; the aquæductus cochleæ, for a little vein from the cochlea; a canal for the Eustachian tube; and, lastly, a smaller canal (canal of Huguier), for the entrance of the tensor tympani muscle and chorda tympani nerve.

It may be observed that the chorda tympani nerve enters the temporal bone at two points: it passes in at one point and out at the other. The temporal articulates with five bones, and gives attachment to fourteen muscles.

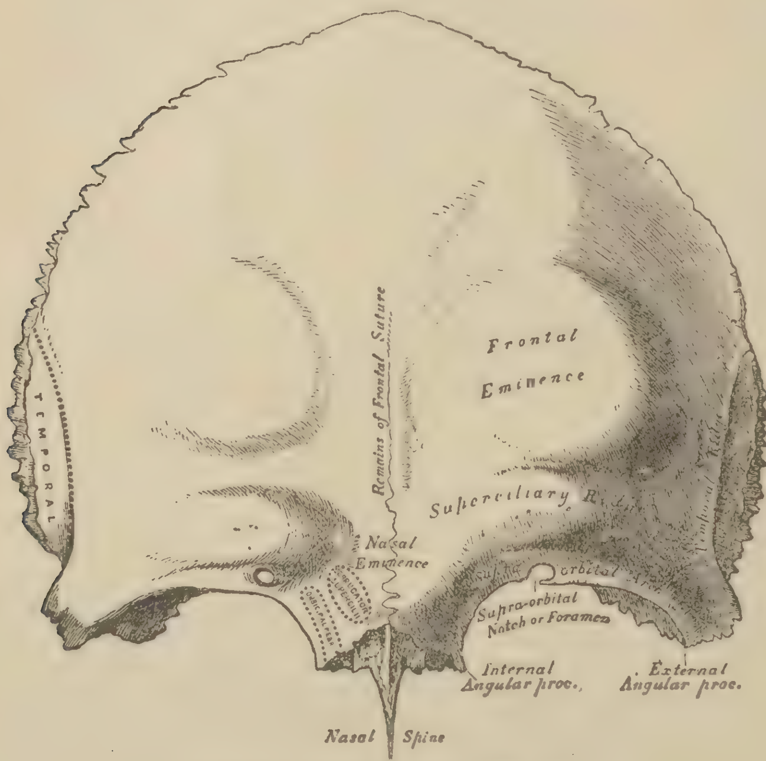
THE FRONTAL BONE.

This bone takes its name from its position in the forehead. It is in part vertical, and in part horizontal. The horizontal portions, called the orbital plates, form the vaults of the two orbits above the eyeballs, and support the anterior lobes of the brain. Between the orbital plates is the ethmoid notch, in which the cribriform plate of the ethmoid completes the anterior portion of the base of the skull. The upper and outer margin of each orbit is called the supra-orbital arch (arch above the orbit). Near the middle of this arch, but somewhat nearer the nose, is the supra-orbital notch, or foramen (sometimes a notch, or groove, and sometimes a foramen) for the supra-orbital vessels and nerve.

Between the two supra-orbital arches is a rough triangular margin,—the nasal notch,—which articulates with the nasal bones and nasal

processes of the superior maxillary bones. Above the nasal notch, and extending outward, somewhat over the arch on either side, the frontal bone consists of two plates, or tables, which contain, in the adult, two irregular cavities — the frontal sinuses. These are lined with mucous membrane, and communicate by the infundibulum (a funnel-shaped passage), with the middle meatus on either side of the nose. The supra-orbital arch terminates externally in the external angular process

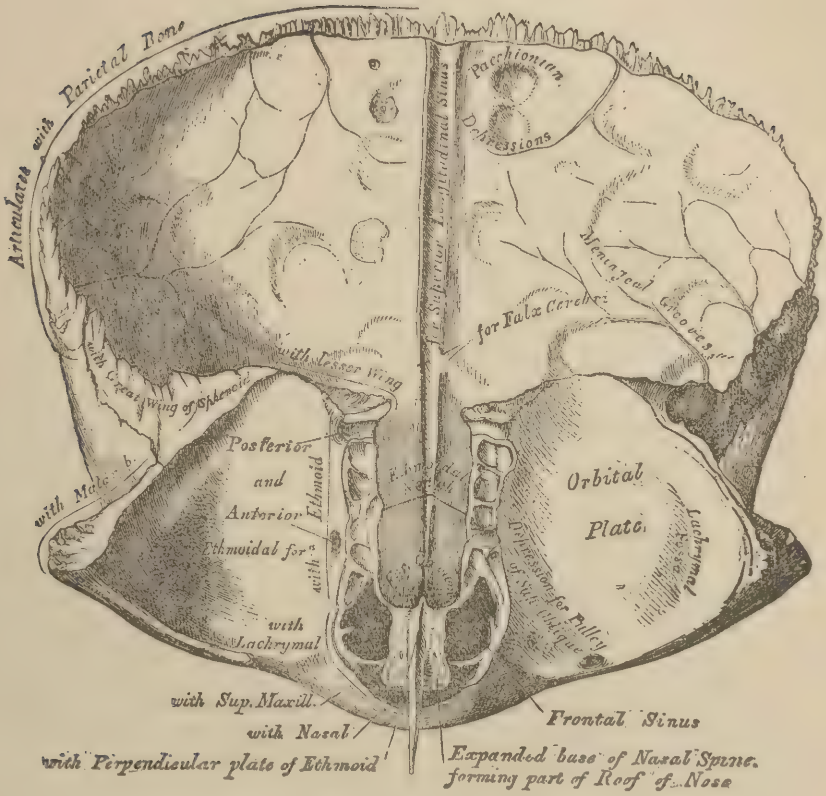
Fig. 28.



FRONTAL BONE — OUTER SURFACE.

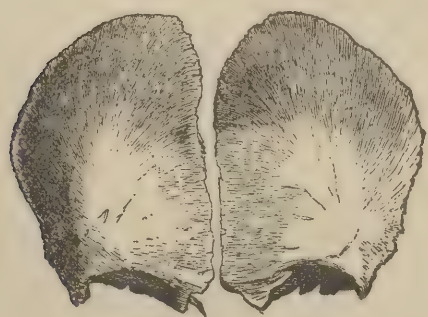
which articulates with the malar bone. The two parietal bones articulate with the posterior and upper portion of the frontal bone, and form the coronal suture. In infancy there is a frontal suture running from the root of the nose upward, in the median line to the anterior fontanel (little fountain). After a few years the frontal suture is usually obliterated, and the two lateral halves of the early frontal bone become united into one. In rare cases the frontal suture is permanent, in which case the subject has two frontal bones instead of one. The

Fig. 29.



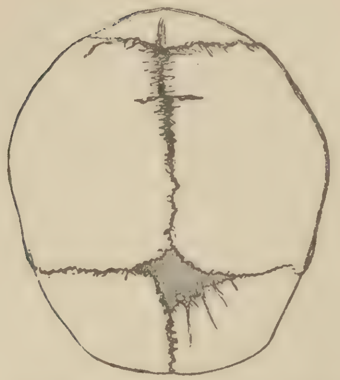
FRONTAL BONE—INNER SURFACE.

Fig. 30.



FRONTAL BONE AT BIRTH.

Fig. 31.



SKULL AT BIRTH, SHOWING THE ANTERIOR FONTANEL AND SUTURES.

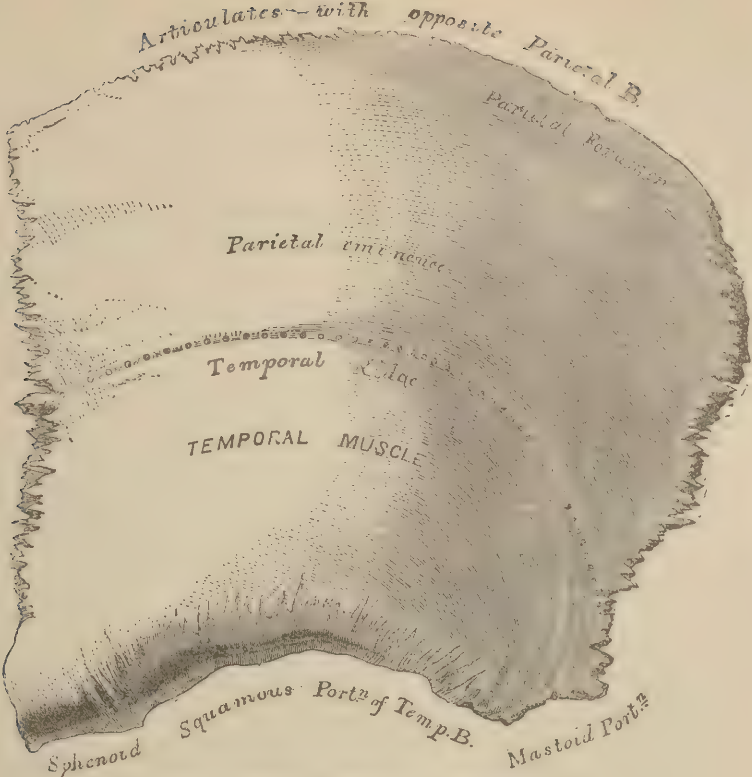
frontal bone articulates with twelve bones, and affords attachment to three pairs of muscles. The three muscles on either side are the temporal, corrugator supercilii, and orbicularis palpebrarum.

THE PARIETAL BONES.

The parietal (wall) bones, two in number, form the sides and roof of the skull. They meet in the median line at the top of the head, and form the sagittal (arrow) suture, which extends from the frontal to the occipital bone. Each bone is nearly quadrilateral in form, convex without and concave within. Its four borders are named, respectively, upper, lower, anterior, and posterior. The upper borders articulate with each other, the lower with the temporal bone on either side, the anterior with the frontal, and the posterior with the occipital bone. Each bone also articulates at the temple with the greater wing of the sphenoid. The lower border is beveled, except a small portion behind that articulates with the mastoid portion of the temporal bone, and is overlapped by the squamous portion of the temporal bone and tip of the great wing of the sphenoid. The anterior border of each bone is serrated (like saw-teeth), and forms half of the coronal suture, by its articulation with the frontal bone. The posterior border is also serrated, and the two bones, united closely with the occipital bone, form the lambdoid ($\wedge$-like) suture. The latter is named from its resemblance to the Greek letter "lambda" λ.

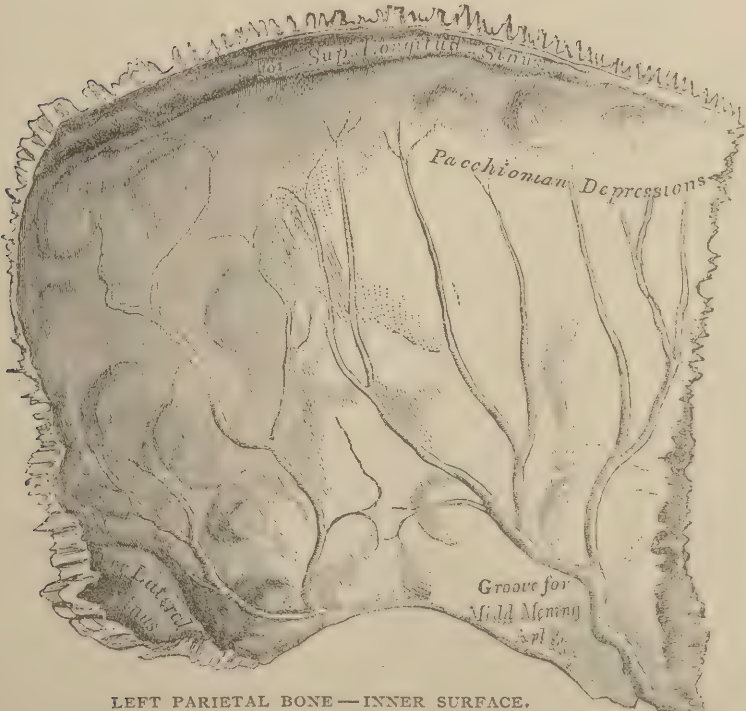
The lower third of the external surface of each bone helps to form the temporal fossa for the attachment of the temporal muscle, which is inserted into the coronoid process of the lower jaw, and is one of the chief muscles of mastication.

Fig. 32.



LEFT PARIETAL BONE — OUTER SURFACE.

Fig. 33.



LEFT PARIETAL BONE — INNER SURFACE.

The concave internal surface of the parietal bone is marked by numerous furrows for the ramification of the meningeal arteries, which feed the meninges (membranes) of the brain.

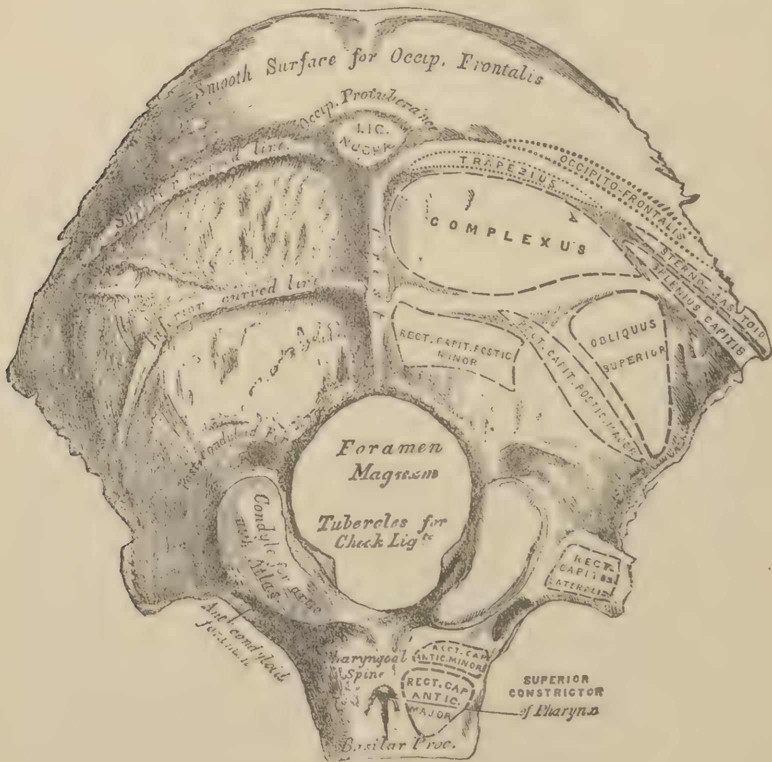
Each parietal bone articulates with its fellow and four other bones, as given above, and affords attachment to one muscle — the temporal.

THE OCCIPITAL BONE.

(Named from its prominence at the back of the head, which receives a blow given in that direction.)

The occipital bone forms the back part of the skull, and also the posterior portion of its base. Being a flat bone it has two surfaces, an outer and inner. The outer surface is convex; the inner, concave.

Fig. 34.



OCCIPITAL BONE — OUTER SURFACE.

It has four borders and four angles. The two lateral angles separate the upper from the lower borders.

The principal points to be noted upon the outer surface, are the

occipital protuberance, the external occipital crest, the foramen magnum (great opening), the two condyles, the two anterior condyloid foramina, the two jugular processes, the basilar process, and the pharyngeal spine. Authors also mention four curved lines—two superior and two inferior, passing outward from the protuberance and crest.

The pharyngeal spine is a mere tubercle, near the center of the under surface of the basilar process, but it marks the point of attachment of the superior constrictor muscle of the pharynx (throat), which is one of the muscles of deglutition (swallowing). The basilar process projects forward from the foramen magnum (great opening), at the base of the brain, to meet the body of the sphenoid bone.

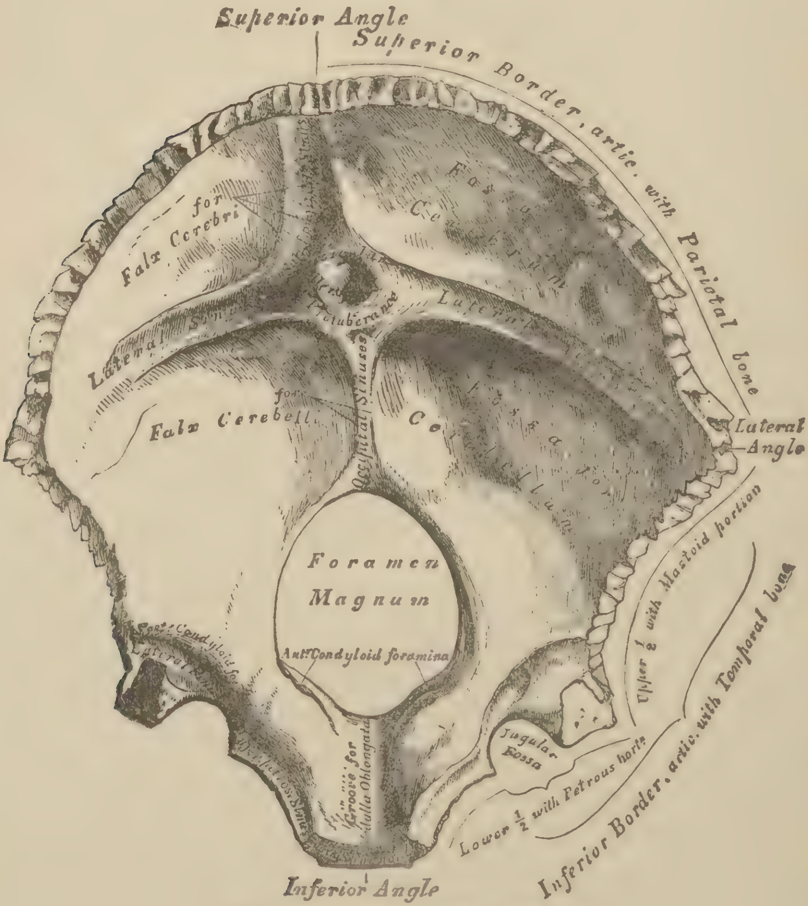
The occipital protuberance, situated in the median line, midway between the summit (superior angle) of the bone and the foramen magnum, itself a small tubercle, forms attachment for the ligamentum nuchæ (ligament of the nape of the neck), which in quadrupeds is a very strong elastic ligament for the support of the head, but in man is only a rudiment. The external occipital crest extends along the median line from the occipital protuberance to the foramen magnum. The foramen magnum transmits the spinal cord, the spinal accessory nerves, and the vertebral arteries. It is an opening three centimeters (more than an inch) in diameter. The condyles lie on either side, somewhat anteriorly, of the foramen magnum, and articulate with the cups of the atlas (first cervical vertebra). To the inner borders of the condyles are attached the check ligaments, which extend to the odontoid (tooth-like) process of the axis (second cervical vertebra), and serve to limit rotation of the head. The check ligaments are also called odontoid ligaments. The two anterior condyloid foramina may be seen just above and in front of the condyles, their names indicating their position. They are sometimes double on each side. They transmit the hypoglossal nerves. The jugular processes — one on each side — lie outside the condyles, and form the back part of the jugular foramen, which transmits on either side the internal jugular vein and the eighth pair of cranial nerves (the glosso-pharyngeal, pneumogastric, and spinal accessory).

The jugular foramen is also called the "foramen lacerum posterius" (posterior lacerated opening). The temporal bones, which articulate with the inferior borders of the occipital bone, form the anterior part of the jugular foramen. The basilar process of the occipital bone becomes united to the body of the sphenoid about the twentieth year of life. The two superior borders of the occipital bone articulate with the two parietal bones, and form the lambdoid suture. At the junction of this suture with the sagittal, is found the posterior fontanel (little foun-

tain), where the beating of the brain may be felt during the first year of life. The two inferior borders articulate with the temporal bones.

Upon the inner surface of the occipital bone we notice four cavities (fossæ), separated by crucial ridges, which intersect nearly opposite the external occipital protuberance. The two superior fossæ receive the posterior lobes of the cerebrum (front, or top brain), and the two inferior receive the lateral lobes of the cerebellum (back, or little

Fig. 35.



OCCIPITAL BONE—INNER SURFACE.

brain). Near the internal protuberance is a smooth depression, where several large venous channels meet, which is called the "torcula Herophili (press of Herophilus). The large groove upon the upper surface of the basilar process is called the basilar groove. It lodges

the pons Varolii (bridge of Varolius) and the medulla oblongata (oblong medulla, or marrow),—both important parts of the brain. The pons lies at the anterior and upper part of the basilar groove ; while the medulla oblongata lies at the lower part, and forms the upper extremity of the spinal cord.

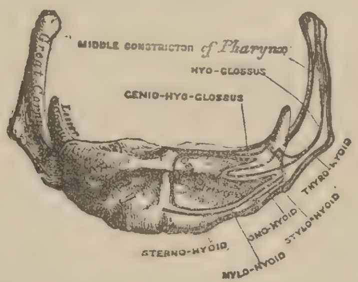
The occipital articulates with six bones, and gives attachment to twelve pairs of muscles. Five of these twelve pairs are recti (plural of rectus, meaning straight) muscles, making altogether ten straight muscles at this part of the head and neck. We have also eight straight muscles of the two orbits, two of the abdomen, and two of the thigh.

The bones articulating with the occipital are the atlas, sphenoid, two temporal, and two parietal.

HYOID BONE.

The hyoid bone (named from its resemblance to the Greek letter "υ"), or os linguæ (bone of the tongue) as it is sometimes called, is situated at the base of the tongue in a plane directed downward and forward. It may be felt high up in the neck, just above the thyroid cartilage (Adam's apple). It is suspended from the styloid process of the temporal bone, on either side, by a slender band,—the stylo-hyoid

Fig. 36.



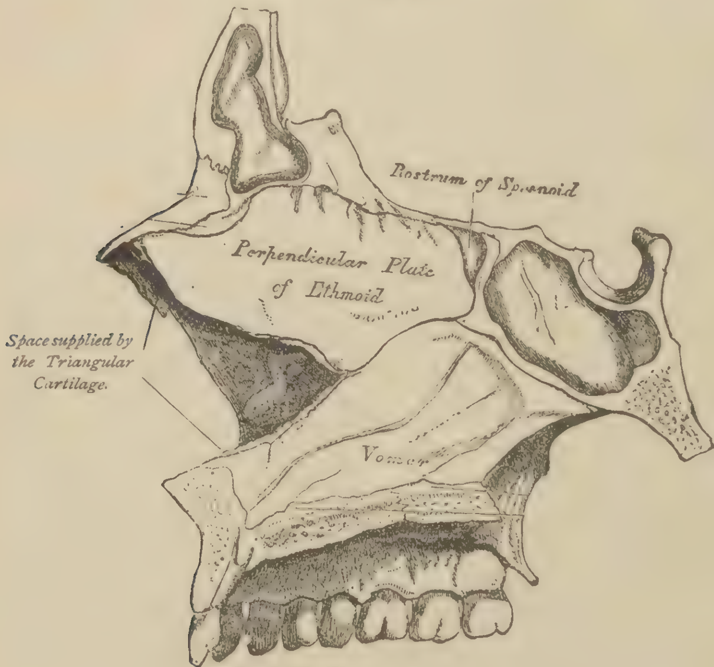
HYOID BONE — ANTERIOR SURFACE.

ligament. It consists of a body and two pairs of cornua (horns), the greater and the lesser cornua. It gives attachment to eleven pairs of muscles—six pairs coming from above, three from below, and two laterally. Eight of these eleven muscles take their name, in part, from the hyoid bone. They are enumerated in the order given above; viz., hyo-glossus, genio-hyo-glossus, genio-hyoid, mylo-hyoid, digastric, and lingual; the sterno-hyoid, omo-hyoid, and thyro-hyoid; and the stylo-hyoid and middle constrictor of the pharynx.

NASAL CAVITIES, OR FOSSÆ.

The nasal cavities, two in number, one on either side of the median septum, are communicating air-passages; and in the adult include the sinuses, or cavities, of the frontal, ethmoid, sphenoid, and superior maxillary bones. The internal wall of each cavity, or nasal fossa, is called the septum narium (partition of the nares, or nostrils), and is formed chiefly by the perpendicular, or central plate of the ethmoid, the vomer,

Fig. 37.

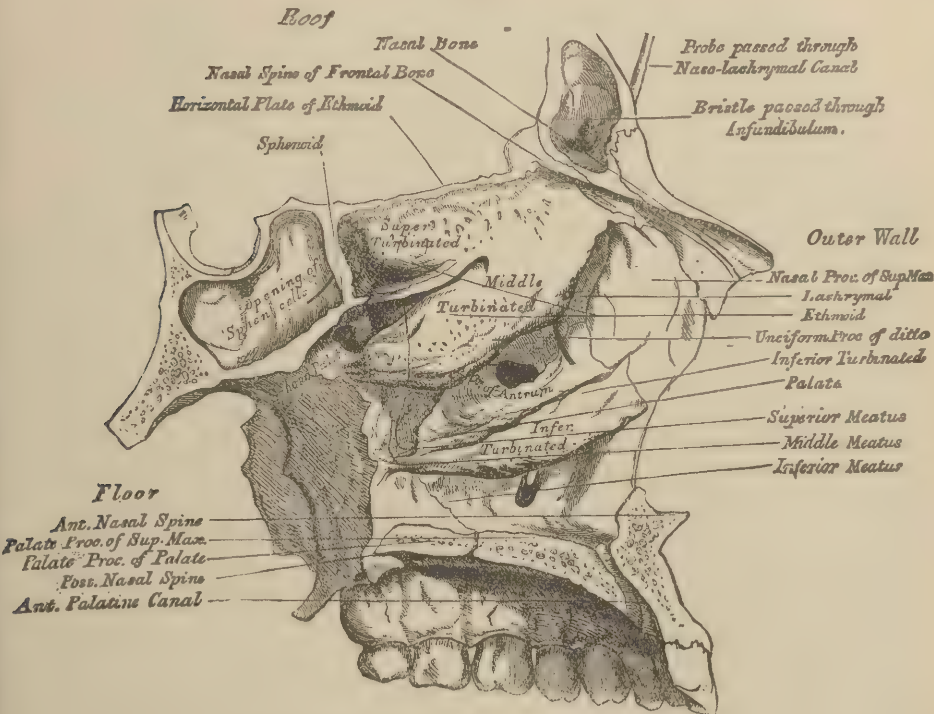


INNER WALL, OR SEPTUM, OF THE NOSE.

and the triangular, or septal cartilage, which completes the septum of the nose at its tip, or lower end. The septum is occasionally perforated, and is not always in the median line. The anterior and posterior openings of the nasal cavities, or fossæ, are called, respectively, the anterior and posterior nares (nostrils). The latter open into the throat (pharynx), the former upon the face. The anterior nares lie in a plane below the floor of the nasal cavity, so that the alæ (wings) and tip of the nose must be raised somewhat, in order to expose to view the floor and inferior meatus of the nasal cavity. Forceps for extracting growths and

foreign bodies from the nose, can be best opened in the vertical plane, since the cavity is narrower in the lateral direction. Each nasal fossa is partially divided by the turbinated bones into three divisions, or passages, and these passages are called, respectively, the superior, middle, and inferior meatus (passage). Each meatus, on either side, lies just below its corresponding turbinated bone. The superior meatus is situated just beneath the superior turbinated bone (really the turbinated

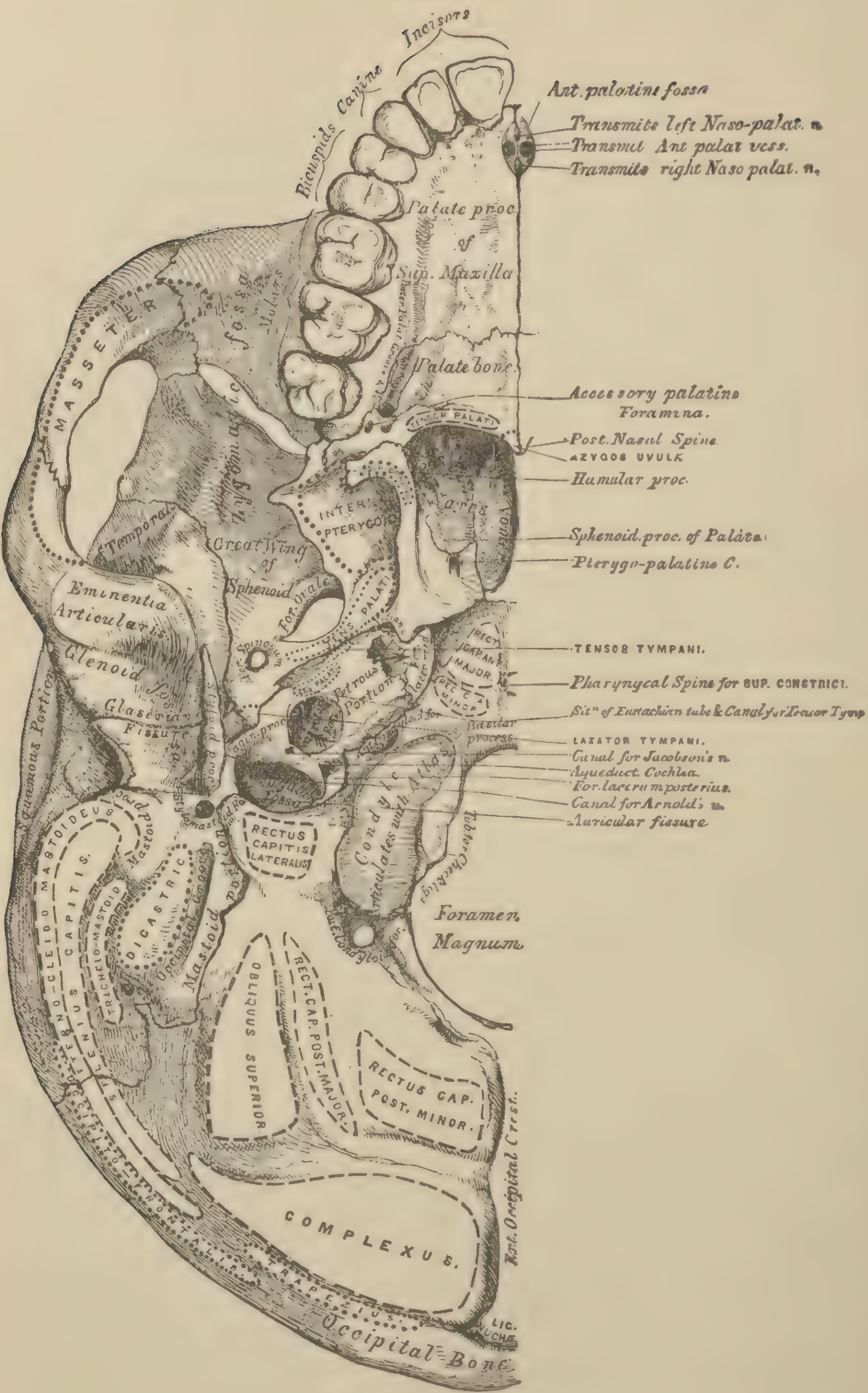
Fig. 38.



OUTER WALL OF THE NASAL FOSSA (CAVITY).

process of the ethmoid bone). The superior meatus is very short, and communicates with the posterior ethmoidal cells, and also with the sphenoidal sinus on either side. The middle meatus communicates with the *anterior* ethmoidal cells, the frontal sinus, and the maxillary sinus. The inferior meatus, longer than the others, communicates with the lachrymal sac through the nasal duct. The turbinated bones are also called spongy bones. The funnel-shaped passage from the frontal sinus on either side to the middle meatus of the nose, is called the infundibulum. The plural is infundibula (funnel-shaped).

Fig. 39.



BASE OF THE SKULL—EXTERNAL, OR UNDER SURFACE.

The frontal sinuses do not exist in children, since the tables of the skull at this part do not begin to separate until the age of puberty, and the sinuses seemed to be formed at the expense of the inner wall of the cranium, as the brain recedes. The *sphenoidal* sinuses are also absent in early youth.

VERTEBRAL COLUMN.

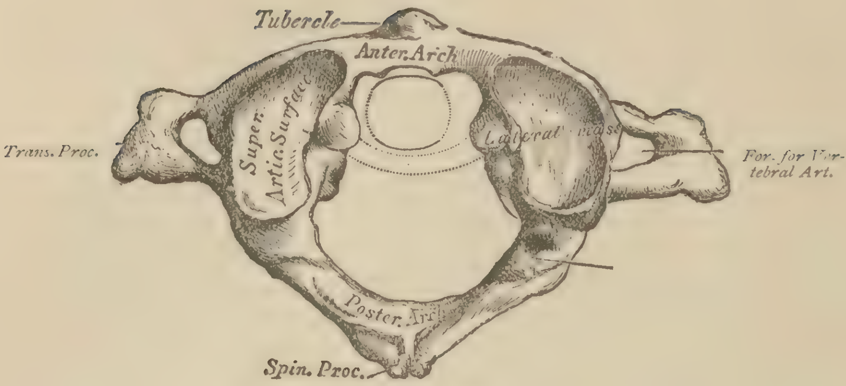
The vertebral, or spinal, column, is improperly called the "backbone," or "spine." (See Fig. 6.) It contains twenty-four bones and extends from the occipital bone of the head to the sacrum of the pelvis. Each bone is called a vertebra (plural, vertebræ). This word signifies "to turn," and gives name to the first great division of the animal kingdom. The vertebrata (vertebrate animals) include all animals that have a vertebral or spinal column. All other animals belong to the invertebrata (invertebrate animals.)

Mammals, birds, reptiles, and fishes are vertebrate animals. Mollusks, radiates, and articulates are invertebrate — have no spinal column. Some authors consider the sacrum and coccyx as a part of the vertebral column, and thus reckon thirty-three vertebræ. But in the adult the five original pieces of the sacrum become united, and can no longer be called vertebræ; and the four of the coccyx also become ossified as one. The spinal column forms a single pillar of support for the head, trunk, and upper extremities. It protects the spinal cord by inclosing it in a bony canal. Its average length is five or six decimeters, or about one third the height of the person. Seen in profile, or viewed from the side, it has three curves, bending forward in the neck and loins, and backward in the chest. These curves give greater elasticity to the column, and greater security to the spinal cord. Viewed in front the column is naturally vertical; and a lateral curvature (although somewhat common) is a deformity.

The bodies of the vertebræ become broader as we descend the neck; then slightly narrower in the upper dorsal region; then gradually widen to the base of the sacrum.

The width of the column between the extremities of the transverse processes, or from side to side, is greatest at the first cervical, first dorsal, and the five lumbar vertebræ; small at the second cervical and last dorsal vertebra, and from these points gradually increases toward the first dorsal vertebra. There are seven cervical (neck) vertebræ, twelve dorsal (back), and five lumbar (loins), all numbered, each region separately, from above downward. The cervical region forms in length about five parts, the dorsal eleven, and the lumbar seven

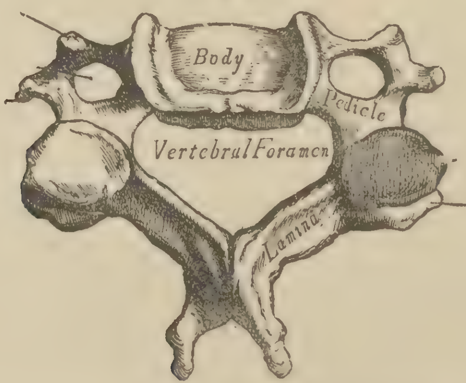
Fig. 40.



THE ATLAS.

parts. The first, second, and seventh cervical vertebræ take distinctive names, and are called, respectively, the atlas, axis, and vertebra prominens. The atlas supports the head, and takes the name of the giant in mythology who carried the world on his shoulders. The axis takes its name from the tooth-like (odontoid) process around which the

Fig. 41.

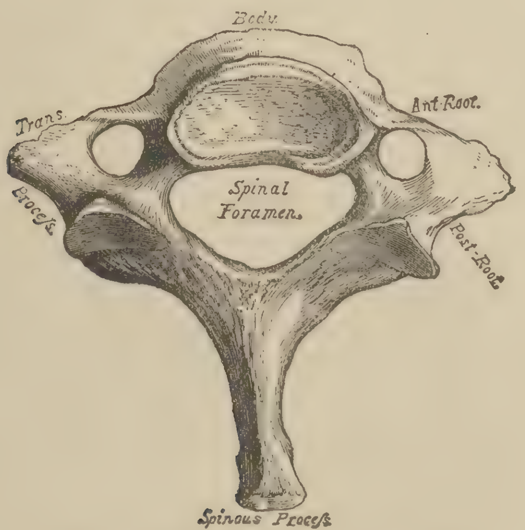


A CERVICAL VERTEBRA. THE SPINOUS PROCESS IS BIFID.

atlas revolves in part. The vertebra prominens (prominent vertebra) is thus named on account of the length of its spinous process, which makes it very prominent, and easily distinguished at the base of the neck between the shoulders. Each vertebra, except the atlas, which has no body, consists of a body, an arch (or spinal foramen), and seven processes — four articular processes, two transverse, and one spinous.

The bodies of the vertebræ increase in size and thickness from above downward; and in position are in front of the spinal cord. Each body has an upper, lower, anterior, and posterior surface. The upper and lower surfaces are slightly concave, and roughened for firmer attachment of the elastic discs that intervene. These elastic discs are often called the intervertebral substances. They are composite (fibro-cartilaginous) in structure, but firm and elastic. The *anterior* surface of the body of each vertebra is convex from side to side, and extends, in the lower part of the column, two thirds of the way around the body, to the pedicle (footstalk), which separates it from the posterior surface of the body. The *posterior* surface of each body forms the anterior part of the spinal canal, and is slightly concave from side to side.

Fig. 42.



VERTEBRA PROMINENS — SEVENTH CERVICAL.

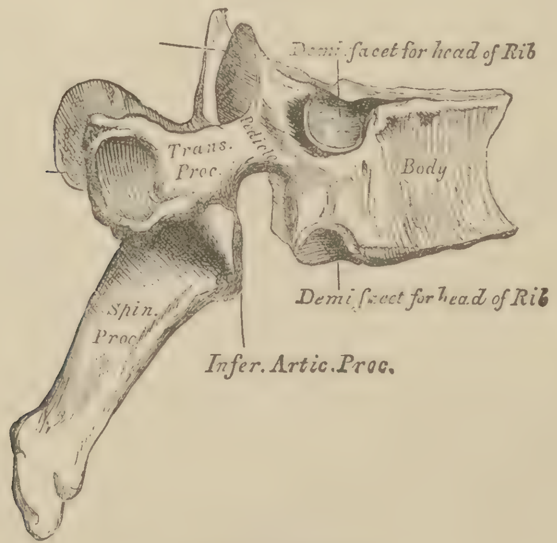
The *arch* of each vertebra, except the atlas, which has two arches, forms the greater part of a large foramen, which transmits the spinal cord. The foramen is called the spinal, or vertebral foramen; and the canal which these foramina form when the vertebræ are placed in position, is called the spinal, vertebral, or neural (nerve) canal.

The arch is formed of two pedicles (footstalks) and two laminæ (plates). The pedicles spring, one on either side, from the posterior surface of the body, and extend outward and backward to meet the laminæ. The pedicle is the portion of bone between the body and the transverse process, and the lamina connects the transverse with

the spinous process. The two laminæ (plates) unite behind the arch, to form the spinous process. The two arches of the atlas are the anterior and posterior. These two arches form about three fifths of the circumference of the atlas, and with the lateral masses inclose a large space occupied by the spinal cord and odontoid process of the axis (second cervical vertebra). The cord is separated from the bony process of the axis by the transverse ligament, which, in the recent state, divides the large foramen of the atlas into an anterior and posterior space. The posterior space corresponds to the spinal foramen.

The *articular processes* form the joints of the vertebræ. They are situated at the junction of the pedicles with the laminæ. There are

Fig. 43.



A DORSAL VERTEBRA.

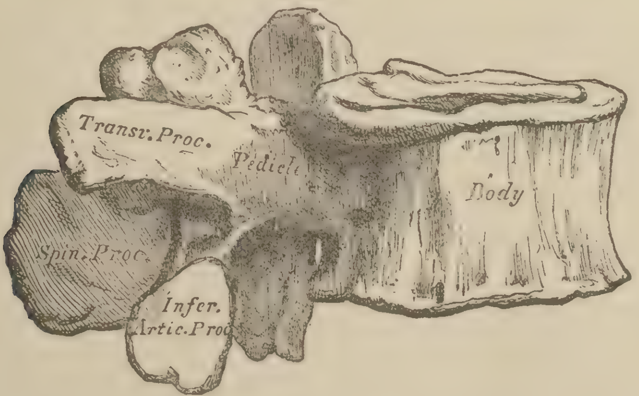
two articular processes, an upper and lower, on either side. Their articular surfaces vary greatly in direction in different regions, and the articulating facets (little faces,—another name for the articular surfaces) of the upper and lower processes in all the vertebræ, except the last dorsal, look in exactly opposite directions, since the lower processes of each bone articulate with the upper processes of the bone below, and, *vice versa*, the upper of each bone articulate with the lower of the bone above.

In the cervical region the upper facets are, at first, nearly horizontal, but grow more and more oblique as we descend, until we reach the last dorsal, whose upper facets are nearly vertical, and looking almost

directly backward. The lower articulating facets of the last dorsal vertebra change direction, to correspond with those of the lumbar region, and look almost directly outward toward each side. They are embraced by the upper processes of the first lumbar vertebra, which look almost directly inward, as do all the upper articulating surfaces of the lumbar vertebræ.

The *transverse*, or *lateral processes*, project outward from the sides of the arch. In the neck the atlas (the first cervical vertebra) has the longest transverse processes, and the axis (the second cervical vertebra) the shortest. From the axis to the first dorsal vertebra the transverse

Fig. 44.



A LUMBAR VERTEBRA.

processes gradually increase in length ; from this point to the last dorsal they diminish in length, and again increase to the last lumbar vertebra, where they are nearly as wide as the sacrum. In viewing the spinal column of the skeleton from behind, we see the spinous processes in the median line, the laminæ each side, and also the transverse processes; and from the front we see the bodies of the vertebræ, and projecting from behind them the extremities of the transverse processes, except in the dorsal region, where the ribs lie in front, and conceal the transverse processes. The tranverse processes of the six upper cervical vertebræ, and sometimes, also, the seventh, are perforated by a foramen (the transverse), which transmits the vertebral artery and vein. They are also grooved superiorly for cervical nerves, and are bifid at their extremity.

The *spinous processes* project backward from behind the arch. These are also bifid in the cervical region. The spinous processes of the second and seventh cervical vertebræ are more prominent than those between them, and can be distinctly felt in the neck. On either side of the spinal canal are foramina, the intervertebral (between the vertebræ)

for the passage of the spinal nerves. These are formed by the apposition of the notches upon the upper and lower borders of the pedicles of contiguous vertebræ.

The third cervical (neck) vertebra corresponds (is in the same horizontal plane) with the bifurcation (division into the internal and external carotid) of the common carotid artery and the upper end of the larynx (the organ of voice).

The fifth cervical marks the lower end of the larynx and pharynx (throat), and the upper end of the trachea (windpipe) and œsophagus (gullet).

The second lumbar vertebra marks the plane of the crura (legs) of the diaphragm, the termination of the spinal cord in the cauda equina (horse's tail) and the commencement of the thoracic duct (large lymphatic duct that passes through the thorax).

The fourth lumbar vertebra marks the termination of the aorta (the great trunk of the systemic arteries).

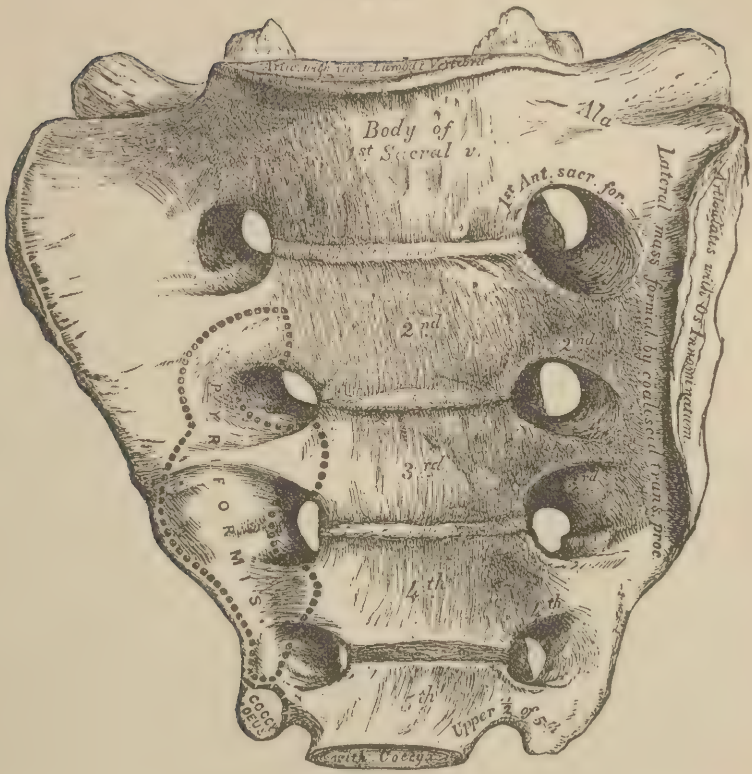
At birth each vertebra has three separate pieces of bone,—one for each lamina and its processes, and one for the body,—and is completely formed about the thirtieth year of life.

THE SACRUM.

The *sacrum* (sacred) is situated at the lower part of the vertebral column, and forms the posterior wall of the pelvis. The entire weight of the head, trunk, and upper extremities rests upon it as upon the keystone of an arch. It is triangular in form, with its base directed upward, and helps to form the pelvis (basin). It is inserted like a wedge between the hip-bones, and appears like five consolidated vertebræ. It is described as having four surfaces — two lateral, an anterior, and a posterior; a base, an apex, and a canal. It has, also, upon both the anterior and posterior surfaces, four pairs of sacral foramina (openings in the sacrum), distinguished as anterior and posterior sacral foramina. These transmit filaments of the cauda equina (horse's tail) from the sacral canal. The latter is continuous with the spinal canal.

The upper portion of each lateral (side) surface articulates with the hip-bone (os innominatum), and is called the *auricular surface*, from its resemblance to the external ear (auricle). The anterior surface is concave and smooth, for the reception of the pelvic organs. It is also called the pelvic surface. The posterior surface is convex and uneven. At its upper border are two articulating processes, which embrace the lower articular processes of the last lumbar vertebra.

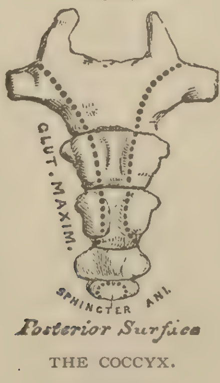
Fig. 45.



THE SACRUM — ANTERIOR, OR INNER SURFACE.

The base of the sacrum is sometimes called the vertebral surface, as it articulates with the intervertebral substance of the last lumbar vertebra. It projects forward at its middle part, and forms the "prom-

Fig. 46.



Posterior Surface

THE COCCYX.

ontory" of the sacrum. The apex articulates with the coccyx below. The sacrum becomes consolidated and complete about the twenty-fifth year, or later. It articulates with four bones, and gives attachment to eight pairs of muscles. The muscles are the pyriform, coccygeus, iliacus, gluteus maximus, erector spinæ, multifidus spinæ, extensor coccygis (not constant), and latissimus dorsi.

The *coccyx* (cuckoo, whose bill it is said to resemble), or rump bone, consists of four or five segments of bone, or rudimentary vertebræ. The gradual diminution in the size of these bones gives to the coccyx a pyramidal form, whose base articulates with the sacrum. It gives attachment to four, and sometimes five, muscles. The four muscles of the coccyx are the coccygeus, on either side, the gluteus maximus behind, the levator ani in front, and the sphincter ani at the apex. At a late period of life the coccyx often becomes joined to the end of the sacrum.

THE COSTÆ (Ribs).

The *ribs* (costæ, singular, costa) are 24 in number, 12 on each side. They are situated obliquely at the sides of the chest. They are numbered from above downward, the first being situated at the base of the neck. The eleven intervals between them are called intercostal (between the ribs) spaces. The first seven ribs are called *true ribs*, because they are connected to the sternum, each by a separate inter-

Fig. 47.

A TRUE RIB (COSTA)—REDUCED IN SIZE.

vening cartilage (the costal cartilage). The remaining five are not connected directly with the sternum, and are called false ribs. Of these, the three adjoining the true ribs — the eighth, ninth, and tenth — are connected by cartilage to the cartilage of the seventh rib; and the lower two, the eleventh and twelfth, are left free at their anterior

extremity, and are called floating ribs. The floating ribs are tipped with cartilage, for the better protection of the soft parts. The vertebral extremity of the rib is called the head of the rib. The true ribs increase in length from above downward ; the false ribs, in the same direction, decrease in length. The first and last ribs articulate with the bodies, respectively, of the first and last dorsal vertebræ. The other ribs usually articulate each with *two* bodies of the dorsal vertebræ. The breadth of the ribs and the width of the intercostal spaces increase steadily, from first to last. The ribs are supported behind by the transverse processes of the vertebræ which lie behind them. The angle of the rib is the part where the bone bends more sharply, to form the side of the chest. It is farther from the head of the bone as the number of the rib increases. The upper and lower borders of the ribs give attachment to the intercostal muscles.

The part of the rib between the head and tubercle — about three centimeters, or a little more than an inch in length — is called the neck. The floating ribs (the two lower) have no neck, or tubercle. In the first rib the tubercle and angle are blended together. The word "costa" signifies a keeper, or guardian ; and the ribs *are* the guardians of the organs of the chest. The *costal cartilages* are twelve in number on each side, but the last two are free, not being connected with the sternum. These cartilages in the fresh state are easily cut with a sharp knife, but when dried are almost as hard as steel. They increase in length from the first to the seventh, and then diminish, like the ribs.

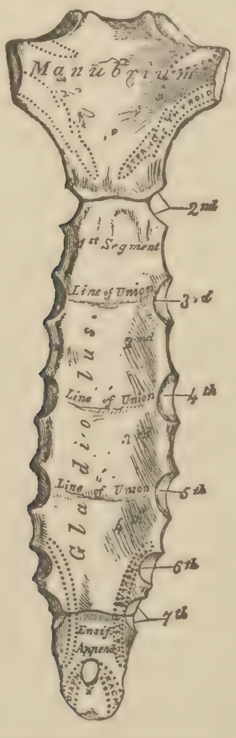
THE STERNUM.

The sternum (solid) is the breast-bone. It is flat, broad above, and terminates below by a pointed cartilage — the xiphoid (sword-like), or ensiform (sword-form) cartilage. In the adult the sternum is composed of the manubrium (handle), the gladiolus (little sword), and the ensiform cartilage, as mentioned above. The latter is also called the ensiform appendix. It is generally cartilaginous till late in life. The manubrium is the upper part of the sternum. It articulates with the sternal end of the clavicle and with the first costal cartilage.

The gladiolus, situated between the manubrium and the ensiform appendix, consists in youth of four pieces, which become united successively to the lower piece, and later in life to the manubrium. The gladiolus is sometimes perforated by a foramen — the sternal foramen. The ensiform, or xiphoid appendix is the tip, or point of the sternum. It may be broad, pointed, or forked. It is often deflected to one side.

The ensiform appendix gives attachment to the linea alba (white line), and to some fibers of the rectus abdominis (straight of the abdomen) muscle. The linea alba is formed by the flattened tendons (aponeuroses) of the abdominal muscles.

Fig. 48.



THE STERNUM—REDUCED IN SIZE.

The sternum, costal cartilages, ribs, and dorsal vertebræ, together, form the walls of the chest, or thorax. The cavity of the thorax contains, in brief, the heart and lungs; but it contains, besides these, numerous blood-vessels, nerves, air-tubes, and other parts. Among these may be mentioned the pulmonary artery and veins, the internal mammary artery, the bronchial tubes and bronchial vessels (arteries and veins), the arch of the aorta, the azygos veins, the superior vena cava, the pericardium (heart-case), and portions of the thoracic duct, trachea (windpipe), and œsophagus; and, in early life, the thymus body.

THE UPPER EXTREMITY.

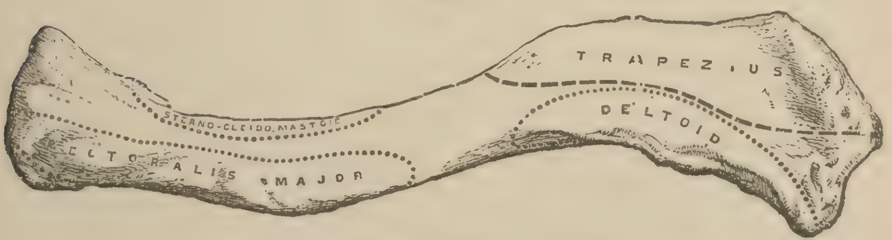
The upper extremity on either side of the body includes the shoulder, arm, forearm, and hand; and is connected to the trunk by muscles and ligaments. It has but one point of attachment to the skeleton, and that is the sterno-clavicular (sternum with the clavicle) articulation in front of the chest.

The interclavicular (between the clavicles) ligament binds the two clavicles together at their sternal ends.

THE CLAVICLE (Collar-bone).

The clavicle (little key) and scapula (shoulder-blade), together, form the shoulder. The clavicle extends from the upper border of the sternum (breast-bone) to the acromion ("height"—it being the

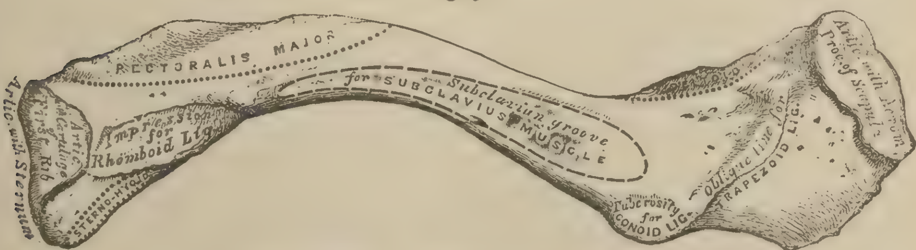
Fig. 49.



LEFT CLAVICLE—ANTERIOR SURFACE.

highest point of the shoulder) process of the scapula. The extremities of the clavicle are designated as the inner, or sternal end, and the outer, or acromial end. The sternal end is triangular in form; the middle portion of the bone round, or nearly so; and the outer end flattened from above, downward. The clavicle gives attachment

Fig. 50.



LEFT CLAVICLE—INFERIOR SURFACE.

to seven muscles. It begins to ossify early in embryonic life (about the sixth or seventh week), and sooner than any other bone in the body; but its epiphysis at the sternal end does not join the shaft till about the twenty-fifth year of life.

The clavicle stays the shoulder, and protects the nerves and vessels that supply the upper extremity.

THE SCAPULA.

The scapula (shoulder-blade) forms the back part of the shoulder. It glides over the third, fourth, fifth, and sixth ribs between the point of the shoulder and the spinous processes of the corresponding dorsal vertebræ. It is a flat, triangular bone with two surfaces, three borders, and three angles. Its two surfaces are the anterior, or inner, and the posterior, or outer. The anterior surface is next to the ribs, and is sometimes called the venter (belly) of the scapula. The posterior, or outer surface is next to the skin, and is often called the dorsum (back) of the scapula. The three borders are the upper (superior), the internal, or vertebral (because it lies next to the vetebræ), and the external, or axillary (because it lies beneath the axilla — arm-pit).

The vertebral (also called the posterior) border is the base of the scapula, while the shoulder-joint forms the apex of the triangle, or the outer (external) angle of the scapula. The other two angles — the upper (superior) and lower (inferior) — form the upper and lower extremities of the internal, or vertebral, border. The outer angle at the shoulder-joint is also called the head of the scapula. The glenoid (glen-like) cavity forms the outer part of the head of the scapula. The back (dorsum) of the scapula is divided by a very prominent ridge (the spine, or spinous process of the scapula) into two very unequal portions, which take the name of fossæ (cavities), although the lower fossa (the infra-spinous fossa — or fossa below the spine) is convex at its middle part. The portion above the spine is called the supra-spinous (above the spine) fossa. The muscles which occupy these fossæ are named from their position, respectively, supra-spinatus and infra-spinatus (above and below the spine). The spine of the scapula terminates, externally, in the acromion (highest point) process, which projects about three centimeters (an inch or more) beyond the shoulder-joint, above and behind, and articulates with the outer (or acromial) end of the clavicle. The anterior surface, or venter of the scapula, forms one broad concave surface — the subscapular (under the scapula) fossa. This fossa is occupied by the subscapularis muscle, which lies between the scapula and the ribs.

Fig. 51.

LEFT SCAPULA—ANTERIOR SURFACE, OR VENTER.

The head of the scapula, situated at the outer angle, is the thickest part of the bone and articulates with the humerus to form the shoulder-joint.

The "neck" joins the head to the main portion of the bone.

The constricted portion, called the neck, is best observed upon the posterior surface. From the upper part of the head and neck arises a

thick, curved process of bone — the coracoid (raven-like; so named by Galen, from its resemblance to the beak of a raven) process. This process extends forward and outward beyond the joint of the shoulder, protecting it in front and above in like manner as the acromion process does above and behind. The coracoid process gives attachment to three muscles and several ligaments. Of the muscles, one (the "Coraco-brachialis," — *brachium*, signifying arm —) extends to the middle of the humerus (bone of the arm); another (the short head of the biceps brachialis, — one of the two upper tendons of this muscle) extends to the radius (one of the bones of the forearm), just below the elbow; and the third (the "pectoralis minor" — small breast-muscle), extends to the third, fourth, and fifth ribs upon the breast, and lies beneath the pectoralis major (greater breast-muscle). On the upper border of the scapula, near the base of the coracoid process, is a semi-circular notch,— the supra-scapular (above the scapula) notch, for the passage of the supra-scapular nerve.

The notch is converted into a foramen by a transverse ligament, or the foramen may be in some instances completely osseous (formed of bone). The nerve is derived from the cervical nerves, and supplies the spinatus (supra-spinatus and infra-spinatus) muscles with motor stimulus.

The scapula gives attachment to seventeen or eighteen muscles, the latissimus dorsi sometimes forming the eighteenth. We have already mentioned six; the others are the *teres*, major and minor (round, greater and less), which extend from the axillary border to the upper part of the humerus; the *trapezius* (named from its form — a quadrilateral having no two sides parallel), extending from the spine of the scapula to the occipital bone, and thence downward along the median line of the body to the last dorsal vertebra; the *deltoid* (delta-like — triangular, like the Greek letter Δ), which extends from the spine, and acromion process of the scapula, and outer third of the clavicle to the outer surface of the humerus, near its middle part; the *omo-hyoid* (shoulder and hyoid bone), from the upper border of the scapula to the hyoid bone; the *triceps cubiti* (three-headed of the ulna), from beneath the head of the scapula, and humerus to the olecranon (head of the elbow) process of the ulna; the *rhomboid*, major and minor (form of a rhombus, greater and less), from the vertebral border of the scapula to the spinous processes of the last cervical, and four upper dorsal vertebræ, the lesser muscle lying above the other, and parallel with it; the *serratus magnus* ("great saw-like," on account of its saw-teeth appearance where it joins the ribs at the side of the body), which extends from the posterior, or vertebral border of

Fig. 52.

LEFT SCAPULA—DORSUM, OR POSTERIOR SURFACE.

the scapula to the outer surface of the first eight ribs on the side of the body, passing in front of the scapula and between the subscapularis muscle and the ribs; the platysma (broad), which extends from the clavicle and acromion process to the lower jaw; and, lastly, the *levator anguli scapulæ* (lifter of the angle of the scapula), which extends from the vertebral border of the scapula, at or near the upper angle, to the three upper cervical vertebræ.

It may be observed that there are three muscles attached to the surfaces of this bone; six to the processes, including the spine; and eight to the borders. The two spinati muscles are attached to the dorsum, or outer surface, and one, the subscapular, to the venter, or inner surface; the deltoid, platysma, and trapezius to the spinous and acromion processes; the small pectoral, biceps, and coraco-brachial to the coracoid process; the omo-hyoid to the upper border; the triceps and two teres muscles to the axillary border; and to the vertebral border, or base, the two rhomboids, serratus magnus, and the levator anguli scapulæ.

THE HUMERUS.

The humerus is the longest and largest bone of the upper extremity, and the only bone of the arm, bearing in mind that the arm only extends to the elbow. It is also called the os brachii (bone of the arm). The principal points to be remembered are the head, anatomical, and surgical neck, greater and less tuberosities, the bicipital groove, the small, or radial head, trochlea, and the outer and inner condyles. The *head* is the segment (portion cut off by a plane passing through) of a sphere, but little less than a hemisphere. It articulates with the glenoid cavity of the scapula (shoulder-blade) and forms the shoulder joint. The *anatomical neck* connects the head with the rest of the bone, and gives attachment to the capsular ligament which invests the joint. The *surgical neck* is the upper portion of the shaft just below the tuberosities, where fracture occurs more frequently than at the anatomical neck, which is larger, and very short. (The shaft is the cylindrical portion of a long bone situated between the two extremities.)

The *tuberosities* are situated exteriorly, at the upper extremity of the bone, the greater being external, and the less more in front.

The two tuberosities are separated from each other by the *bicipital groove*, which lodges the long tendon of the biceps (two-headed) muscle. The outer and inner borders of the bicipital groove are named by Gray, respectively, the anterior and posterior bicipital ridges.

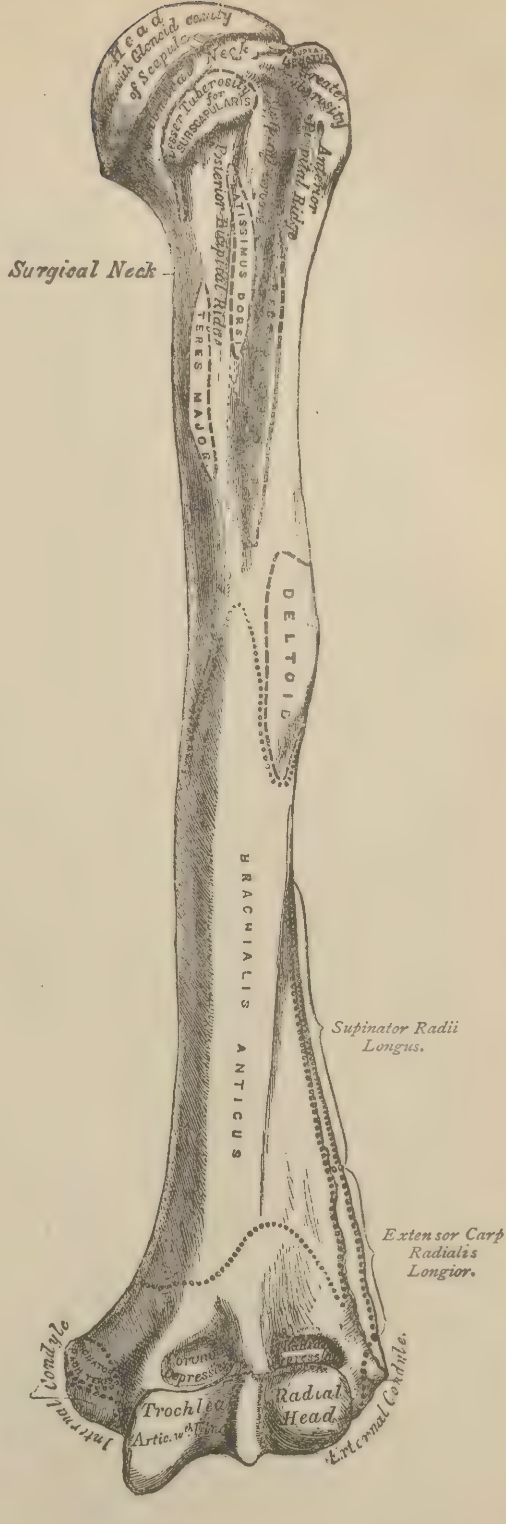
The *greater tuberosity* has at its upper and back part three facets (little faces, or flattened surfaces), which give attachment from before backward, in the order named, to the supra-spinatus, infra-spinatus, and teres minor muscles,—all of which connect this bone with the scapula (shoulder-blade).

The *smaller tuberosity* is situated upon the inner side of the bicipital groove. It gives attachment to the sub-scapularis (under the scap-

Fig. 53.

LEFT HUMERUS — POSTERIOR VIEW.

Fig. 54.



LEFT HUMERUS — ANTERIOR VIEW.

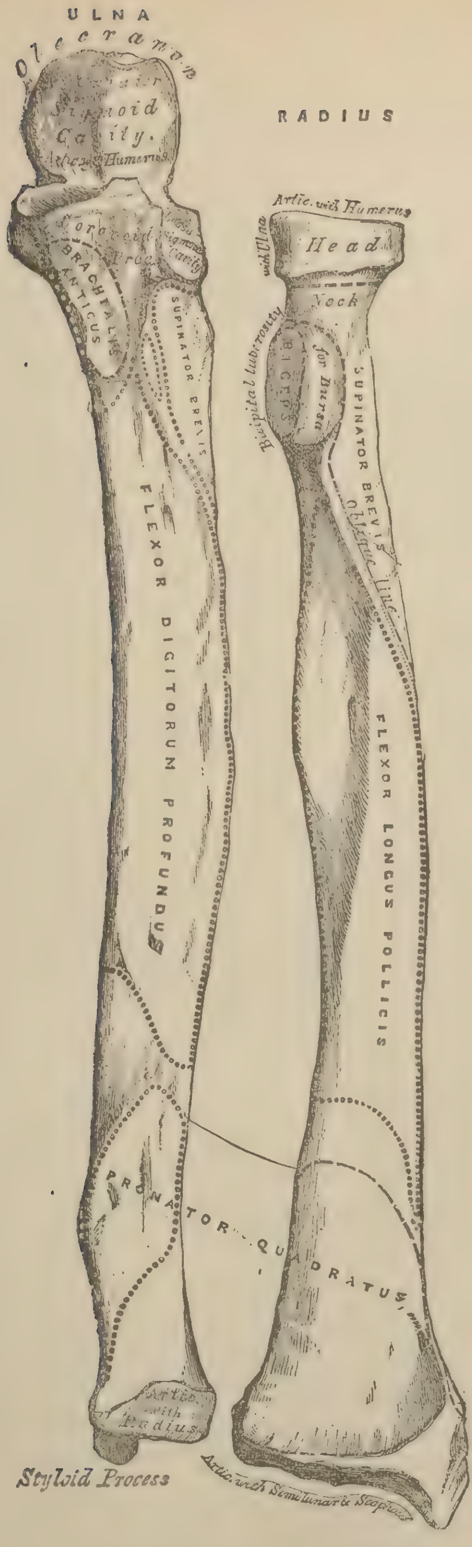
ula) muscle. The *bicipital groove* gives attachment to three muscles — the latissimus dorsi (broadest of the back), pectoralis major (greater breast), and teres major (greater round). The lower extremity of the humerus is flattened, and curved slightly forward. At its broadest part we find the inner and outer condyles, which form the prominences at the sides of the elbow. The inner condyle is much more prominent than the outer. The articular surface extends a little — one or two centimeters — below the condyles, and articulates with the two bones of the forearm. The outer portion articulates with the head of the radius, and is called the radial head, or smaller head of the humerus; and the inner portion articulates with the ulnar, and is called the trochlea (a pulley, or turning-point). Above the trochlea, in front, is the coronoid (Greek, "κορωνη," a crow) fossa, which receives the coronoid process of the ulna during flexion of the forearm, and opposite, on the other side of the bone, is the olecranon (head of the elbow) fossa, which receives the olecranon process during extension of the forearm. Twenty-five muscles are attached to the humerus — 7 to the upper end, 5 to the shaft, and 13 to the condyles (5 to the inner and 8 to the outer condyle).

Those of the inner condyle, five in number, are the superficial pronators (from "pronus," inclining forward, as when we turn the hand inward to look upon its back), and the flexors (benders); and those attached to the outer condyle, eight in number, are the superficial supinators (from "supinus," lying on the back, as when the hand is turned outward, and the palm upward), and the extensors (stretchers, or straighteners). Of the 25 muscles, 20 are attached to the upper and lower extremities, and 5 to the shaft. The 5 attached to the shaft are the deltoid, coraco-brachial (or coraco-brachialis), anterior brachial (brachialis anticus), triceps of the ulna (triceps cubiti), and subanconeus (the small of the elbow). Of those attached to the upper extremity, 3 are attached to the greater tuberosity, 3 to the bicipital groove, and 1, the subscapula (under the shoulder-blade), to the smaller tuberosity.

THE ULNA.

The ulna ("ō-le-ne" in Greek and cubitus in Latin) is the longer of the two bones (ulna and radius) of the forearm. The ulna is situated on the same side as the little finger. Like all long bones, it has a shaft and two extremities. The upper extremity, where it articulates with the humerus above and radius at the side, is much larger than the lower extremity, which articulates with the radius, only, and is separated from the bones of the wrist by an intervening fibro-cartilage (fibrous tissue

Fig. 55.



BONES OF THE LEFT FOREARM — ANTERIOR SURFACE.

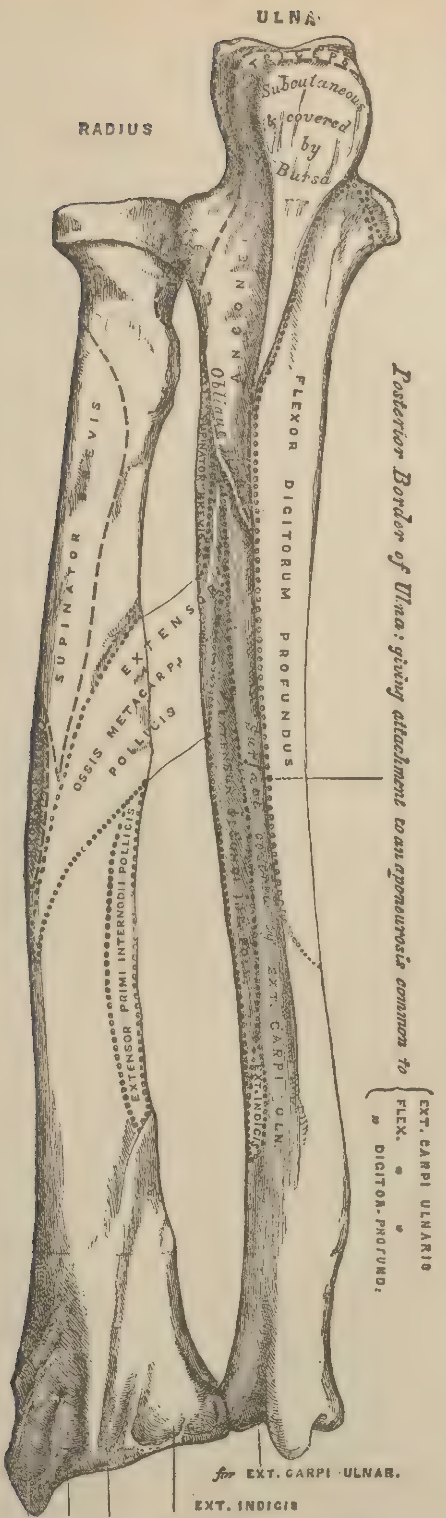
and cartilage united, making the structure dense, elastic, firm, and flexible). The part of the ulna that articulates with the trochlear surface of the humerus is the *greater sigmoid cavity;* and that articulating with the head of the radius on the outer side, is the *small* (lesser) *sigmoid cavity* of the ulna. There is also a sigmoid cavity of the radius, which articulates with the lower extremity (head) of the ulna. (Sigmoid signifies resemblance to the Greek letter "Sigma," corresponding to our "S," and was made, when standing in the middle of a word, much like our "O," as follows, σ, so that a sigmoid cavity is ovoid, or oval).

The greater sigmoid cavity separates the coronoid process in front from the olecranon (head of the elbow) process, which completes the joint behind. The *olecranon process* corresponds to the patella (knee-pan) at the knee, and is sometimes distinct or detached from the ulna, forming a true sesamoid bone. At the front part of the coronoid process, where it joins the shaft of the bone, is a rough triangular surface, or tubercle, for the attachment of the anterior brachial (brachialis anticus) muscle. This muscle extends to the lower half of the humerus, and assists the biceps (two-headed muscle) to flex the forearm. The olecranon process forms the prominence, or point of the elbow when bent, and gives attachment to the triceps (three-headed) muscle, as the patella (knee-pan) does to the triceps of the leg. (The triceps of the leg — "triceps cruris" — is also called the quadriceps extensor femoris [four-headed extensor of the thigh]). During flexion of the forearm the apex of the coronoid process of the ulna is received into the coronoid fossa (or depression) of the humerus; and during extension, the olecranon process of the ulna is received into the olecranon fossa of the humerus. The lower extremity (head) of the ulna is small, rounded on the outer side where it plays in the sigmoid cavity of the radius, and terminates on the inner side in the styloid (pencil-like) process, which becomes prominent at the wrist, while the person looks upon the back of his hand. The external border of the shaft of the ulna gives attachment at its two middle fourths to the *interosseous* (between the bones) *membrane*, which connects this bone to the internal border of the radius.

The olecranon process usually unites with the shaft at about the fifteenth year of life, but the lower epiphysis unites some years later.

Thirteen muscles, and sometimes another (the flexor longus pollicis — long flexor of the thumb —), making fourteen, are attached to the ulna. They are mostly flexors and extensors.

Fig. 56.



Extensor Carpi Rad. Breviors. *Extensor Secundi Internodii Pollicis.*

BONES OF THE LEFT FOREARM — POSTERIOR VIEW.

THE RADIUS.

The *radius* (rod, or spoke) lies external to the ulna, and on the same side with the thumb. The radius is parallel with the ulna while the person looks upon the palm of his hand, but crosses it while he looks upon the back of the hand. The lower extremity is the larger, and enters largely into the structure of the wrist-joint.

The upper and smaller extremity of the radius at the elbow is called the head, while the head of the ulna articulates with its lower extremity at the wrist.

The lower extremity (at the wrist) has two articulating surfaces, or facets (little faces)—one on the inner side for the head of the ulna, the other larger, and partially divided into two smaller facets, for the scaphoid and semi-lunar bones of the wrist. It has also a styloid process, which is nearly opposite the styloid process of the ulna. These processes give attachment to ligaments of the wrist. The posterior (or dorsal) surface of the lower extremity has three distinct grooves, for tendons of the extensor muscles. There are, also two grooves on the outer surface of the styloid process, for two tendons of extensors of the thumb.

The upper extremity of the radius presents a head, neck, and tubercle, or tuberosity. The latter is for the attachment of the biceps flexor cubiti (double-headed flexor of the forearm), called also biceps brachii (two-headed of the arm), or simply biceps. The biceps of the arm extends along the anterior and internal part of the arm to the coracoid process, and upper margin of the glenoid cavity of the scapula (shoulder-blade) at the shoulder.

The head of the radius is slightly concave above, where it articulates with the smaller (or radial) head of the humerus, and cylindrical in form where it articulates with the smaller sigmoid cavity of the ulna. The head of the radius is held firmly against the outer side of the ulna by the orbicular ligament. The neck is the constricted portion of the upper extremity between the head and tubercle. The internal border of the shaft is sharp and distinct, and affords attachment along its middle half to the interosseous (between the bones) membrane. Near the upper part (near the elbow) the radius and ulna are bound together by a round, fibrous cord (the *oblique*, or *round* ligament), which extends from the tubercle of the ulna obliquely outward and downward to a point just below the tubercle of the radius.

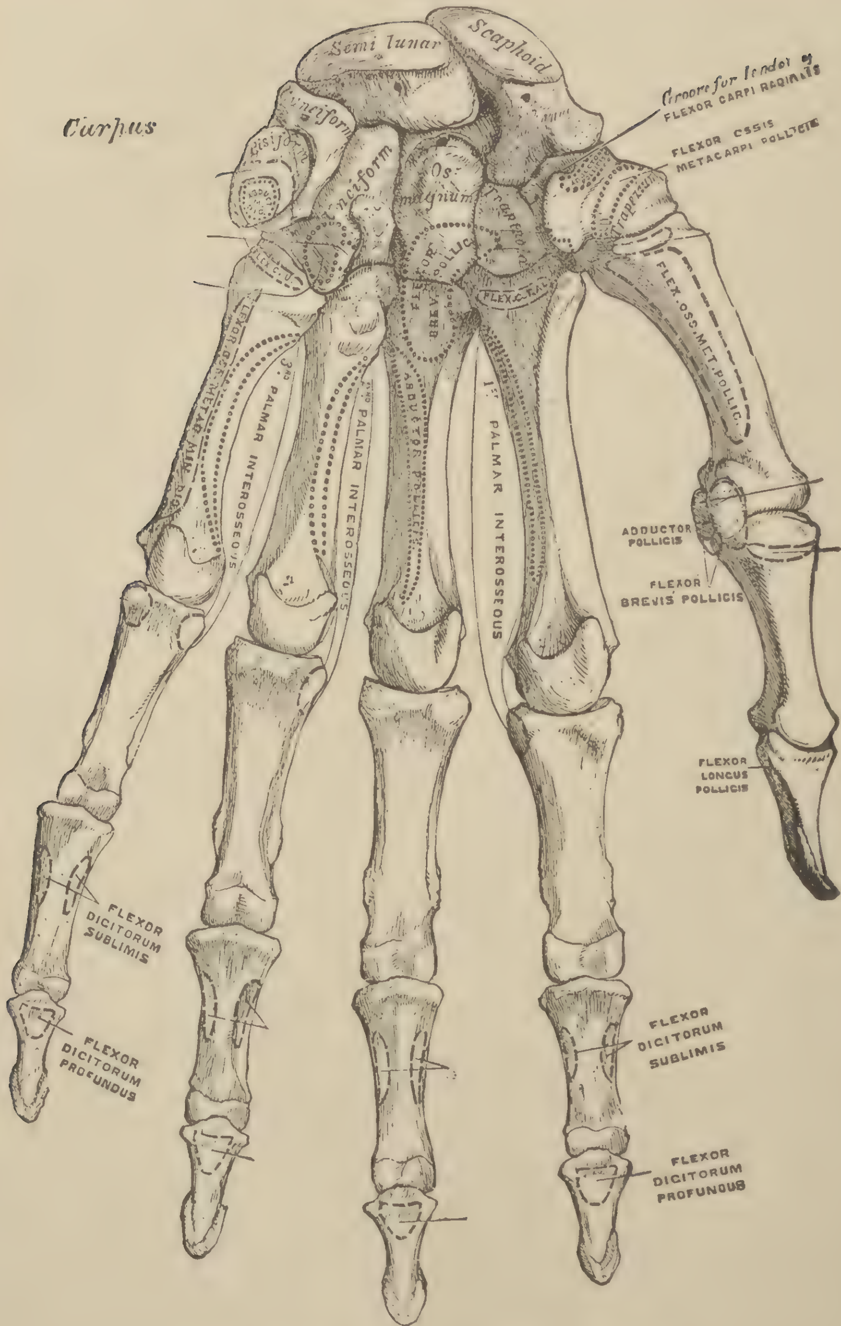
The radius articulates with the humerus above, with the scaphoid and semi-lunar bones below, and with its fellow, the ulna, at *both*

extremities. It gives attachment to nine muscles — extensors, flexors, pronators (rotating the hand from without inward, while the lower end of the radius passes before the ulna), and supinators (carrying the hand outward, so as to bring the ulna and radius parallel, and the palm forward, or upward).

THE CARPUS.

The carpal (wrist) bones are eight in number. They occupy the space between the lower end of the radius and the bases of the metacarpal (*after* the carpal, or wrist) bones, and are situated in two rows of four bones each. The upper row (radial, or proximal row) contains the scaphoid (skiff-like), semi-lunar (half-moon), cuneiform (wedge-form), and pisiform (pea-form). This row forms a curve with the convexity next to the radius; or, in other words, the scaphoid and semi-lunar are rounded above where they articulate with the radius, so as to allow of a lateral motion to the hand. The pisiform is the smallest of the carpal bones, and articulates only with the cuneiform. It forms the prominence which may be felt just below the ulna, at the border of the palm of the hand. The cuneiform articulates above with the fibro-cartilage, which separates it from the ulna, and with three of the carpal bones. It is situated at the inner side of the wrist above the little finger, and partially between the semi-lunar and unciform (hook-form) bones. The latter forms one of the bones of the lower row. [The lower row of wrist (carpal) bones is the distal (farther away), or metacarpal row.] The remaining three of the lower row are the os magnum (great bone), trapezoid (trapezium-like), and trapezium (a quadrilateral, that has no two sides parallel). Naming the bones of the lower row in the same order as the upper were named, from without inward, we have the trapezium, trapezoid, os magnum, and unciform; the latter being on the inner side, with the little finger. The os magnum (great bone), as its name implies, is the largest bone of the wrist, and occupies its center, articulating with seven bones. The first and last bone of each row assists to form on the anterior, or palmar surface, two prominences, or piers, one on the radial side of the wrist and the other on the ulnar side. To these prominences, stretching across from one to the other, is attached the *anterior ligament* of the wrist, beneath which play the tendons of the flexor muscles of the fingers — flexor sublimus ("high" attached to the inner condyle of the humerus), flexor profundus (deep), and flexor longus policis (long of the thumb).

Fig. 57.



BONES OF THE LEFT HAND — PALMAR SURFACE.

The *posterior ligament* forms a sheath on the dorsal surface of the wrist, for the extensor tendons in their passage to the fingers. There are six of these extensor tendons, each having a separate sheath with a synovial ("with egg," secreting a fluid like the white of an egg) membrane.

There are muscles attached to some of the carpal bones, but none to the scaphoid, semi-lunar, or cuneiform of the wrist; but the scaphoid and cunneiform of the ankle give attachment to muscles. The os magnum and trapezoid have one muscle each; the unciform and pisiform two each; and the trapezium, three muscles. At birth all the bones of the wrist are cartilaginous. Ossification commences in the os magnum during the first year, and in the pisiform, the last to ossify, about the twelfth year.

THE METACARPUS.

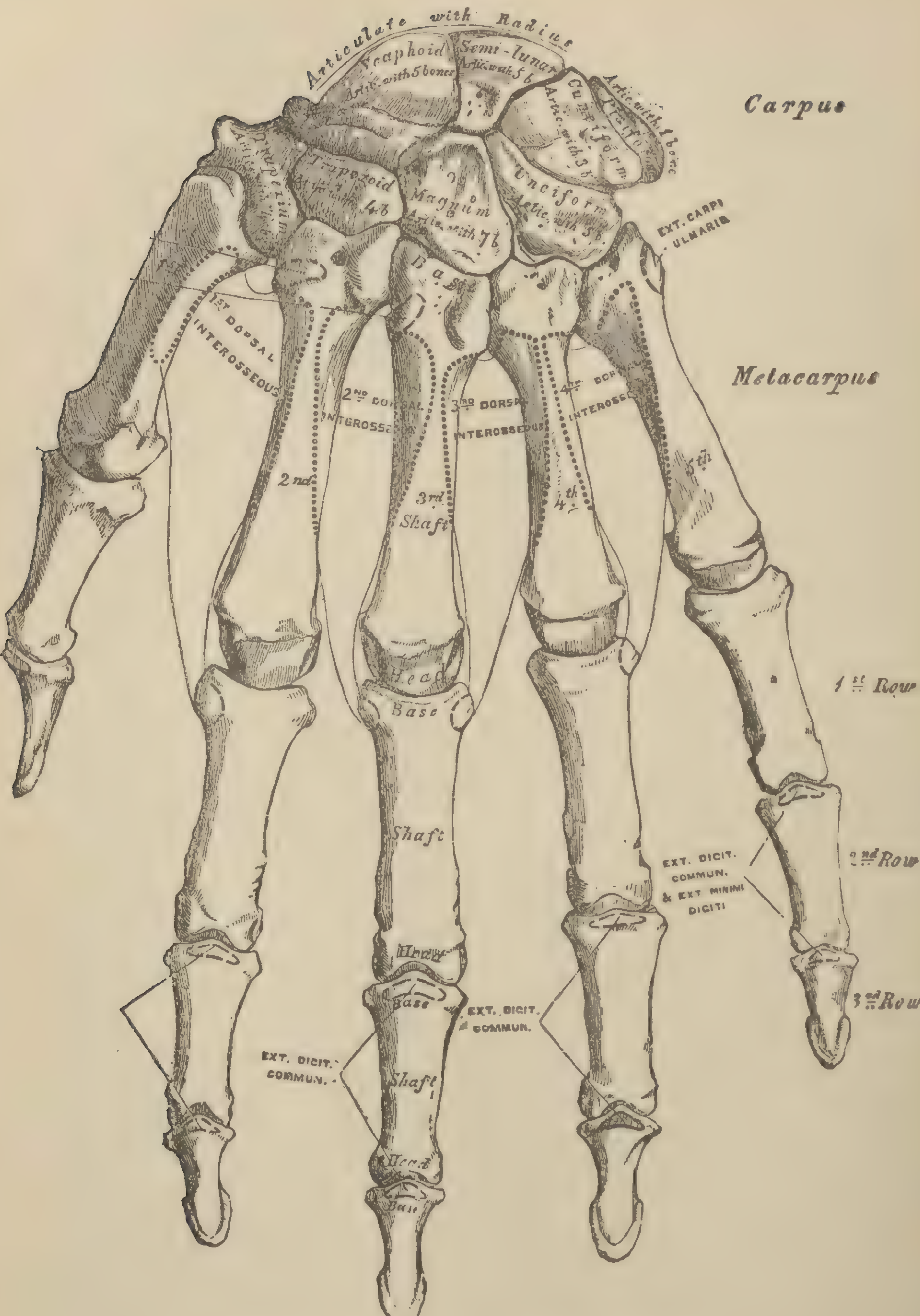
(See Figs. 57 and 58.)

The metacarpal (after the wrist) bones, five in number, are placed in the palm of the hand, longitudinally between the wrist and first phalanx (row) of the fingers. They are numbered from without inward, the first being at the base of the thumb (pollux), the fifth at the base of the little finger. Each has a shaft, base, and head. The base is also called the carpal (wrist) extremity, and the head, the digital (finger) extremity. As they leave the wrist they diverge, so as to meet the bases of the five bones that form the first phalanx of the fingers. The middle one (the third) is the longest, and that for the thumb (the first) the shortest. The odd numbers (1, 3, and 5) articulate at the wrist, or bases, each with one carpal bone,—the trapezium, os magnum, and unciform, respectively. The second, that for the index finger, articulates with three carpal bones (trapezium, trapezoid, and os magnum), and the fourth with two carpal bones (os magnum and unciform). All but the first metacarpal bone articulate at the wrist with the metacarpal bone adjoining, but, diverging as they approach the fingers, their heads are separate from each other. Each metacarpal bone articulates at its head with the corresponding bone of the first phalanx.

Seventeen muscles are attached to the metacarpal bones. There are 2 flexors of the wrist, 2 of the thumb, and 1 of the little finger; 3 extensors of the wrist, and 1 of the thumb; 1 adductor of the thumb; 4 dorsal interosseous, and 3 palmar interosseous muscles.

The interosseous muscles (interossei) occupy the intervals between the metacarpal bones upon the dorsal and palmar surfaces.

Fig. 58.



BONES OF THE LEFT HAND—DORSAL SURFACE.

THE PHALANGES.

(See Figs. 57 and 58.)

The phalanges (lines, rows, or ranks) are the three ranks, or rows of bones found in each hand and foot, and forming the fingers and toes. The first and second ranks of hand or foot contain each five bones; while the third rank, or row, contains only four bones, since the thumb and great toe have only two bones each, and do not enter the third rank (phalanx).

The bones that form each phalanx in the hand or foot are numbered like the metacarpal or metatarsal bones, fingers, and toes, from the side of the hand or foot on which is situated the great toe or thumb, toward the side on which is situated the little toe or little finger. The fingers (digits) are named as follows: —

1. Thumb (pollex, or digitus primus).
2. Index finger (digitus secundus).
3. Middle finger (digitus tertius).
4. Ring finger (digitus quartus).
5. Little finger (digitus minimus).

The latter may also be called digitus quintus (fifth finger).

The toes are sometimes called "digits" (fingers), since they have nearly the same organization as the fingers. The bones of the first phalanx articulate, in the hand, with the metacarpal bones and second phalanx, and in the foot, with the metatarsal (after, or next, to the ankle) bones and second phalanx; the second phalanx in both hand and foot, except in the great toe and thumb, articulates with the bones of the first and third phalanges (or rows); and the third phalanx articulates, in hand and foot, with the second phalanx.

Twenty muscles are attached to the phalanges of the hand, and 23 to those of the foot.

In the hand we have attached to the bones of the phalanges, 5 extensors, 5 flexors, 1 adductor of the thumb, 1 abductor of the thumb and 1 of the little finger, 4 dorsal interosseous and 3 palmar interosseous (or interossii) muscles.

In the foot there are attached to the bones of the phalanges, 3 extensors, 5 flexors, 1 adductor (adductor pollicis — of the great toe), 1 abductor of the great toe (pollicis), 1 abductor of the little toe (minimi digiti), 1 transverse, 4 lumbrical (lumbricales), 4 dorsal interosseous, and 3 plantar interosseous.

Fig. 59.

ARCH OF THE FOOT.

Having described the phalanges of the foot in connection with those of the hand, we shall next describe the bones of the foot adjoining and articulating with the first phalanx, or base of the toes.

METATARSAL BONES.

(See Figs. 60 and 61).

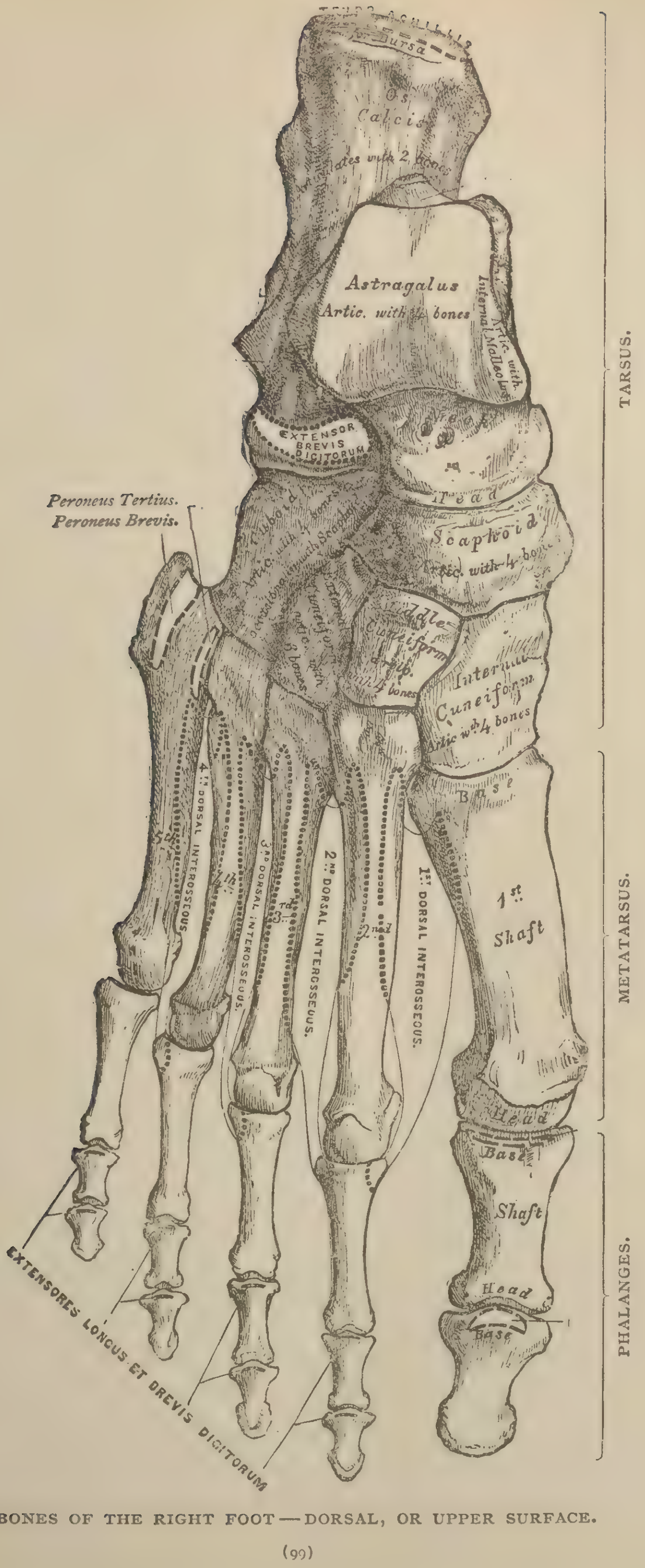
The *metatarsal* (next to the tarsal, or ankle) *bones* form the instep. They are five in number, and are placed longitudinally between the tarsus (originally a crate, or mat, and now applied to the posterior part of the foot, and also to the cartilage found in the eyelid) and first phalanx of the toes.

The posterior extremity of each bone is the base of the bone, and its anterior extremity, the head.

The metatarsal bones are numbered from within outward like the toes. The first is shortest and largest; the second is the longest. The first articulates at its base with the internal cuneiform (wedge-form) of the tarsus (ankle); the second articulates at its base with the middle cuneiform behind and the internal and external cuneiform at its sides; the third, with the external cuneiform; and the fourth and fifth, with the cuboid of the ankle. The fourth also articulates with the external cuneiform at its inner side. Their heads are rounded, and articulate with the concave surfaces at the base of the bones that form the first phalanx of the toes.

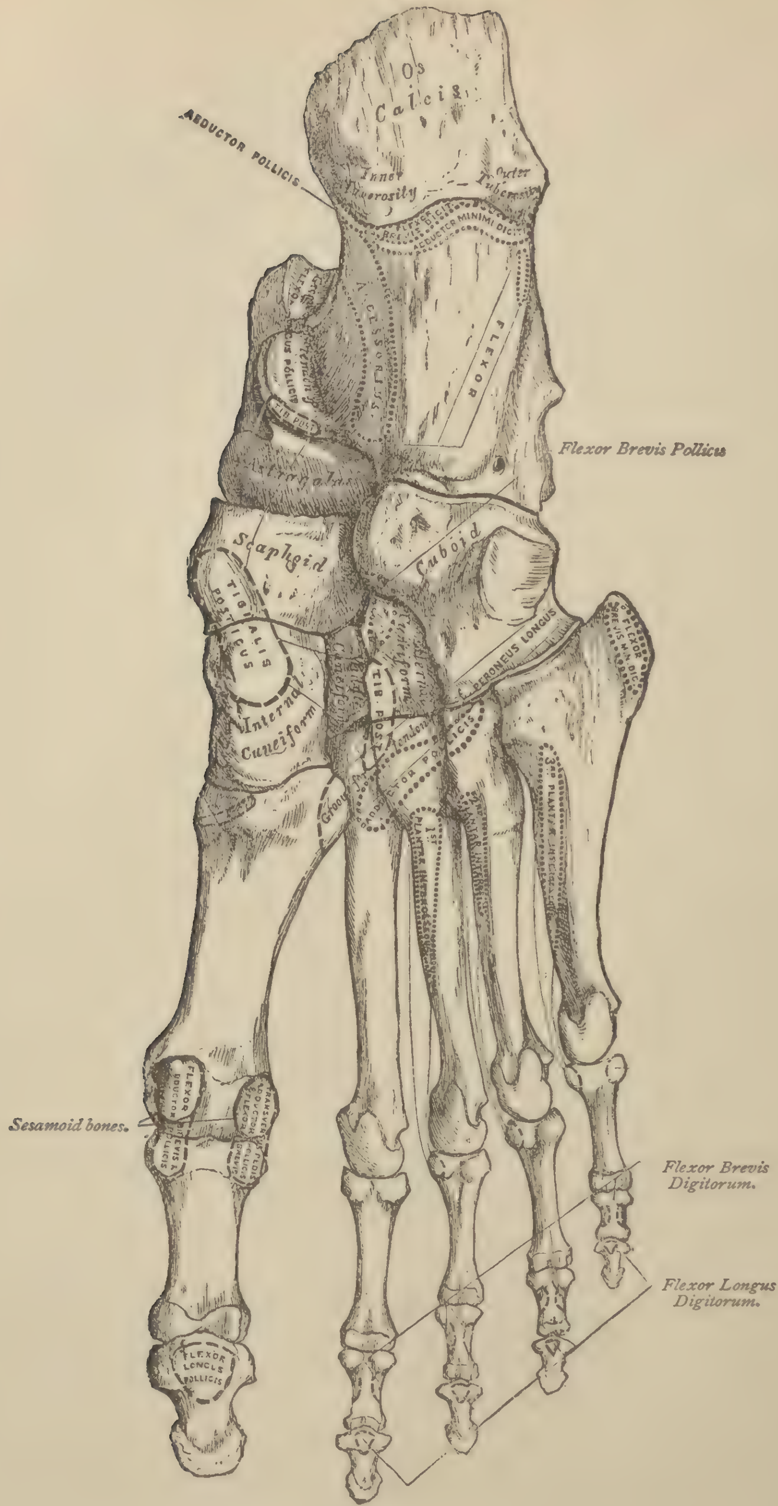
There are 14 muscles attached to the 5 metatarsal bones of each foot. These are the 4 dorsal interosseous, 3 plantar interosseous, 3 peroneal (peroneus longus, brevis, and tertius), anterior tibial (tibialis anticus), adductor of the great toe (adductor pollicis), flexor of the little toe (flexor minimi digiti), and transverse of the foot (transversus pedis).

Fig. 60.



BONES OF THE RIGHT FOOT — DORSAL, OR UPPER SURFACE.

Fig. 61.



BONES OF THE RIGHT FOOT—PLANTAR, OR UNDER SURFACE.

THE TARSUS.

The bones of the *tarsus* (ankle) are seven in number. They are the os calcis, or calcaneum (heel-bone), the astragalus (die, or cube), the cuboid (cube-like), the scaphoid (skiff-like), and three cuneiform (wedge-form). The cuneiform are designated by number, size, or position. They are numbered from within outward, first, second, and third cuneiform, corresponding to the internal, middle, and external cuneiform. The internal cuneiform is the largest and the middle cuneiform the smallest of the three cuneiform. The internal cuneiform is situated at the inner side of the foot, between the scaphoid behind and the base of the first metatarsal in front. It gives attachment to the anterior, and posterior tibial muscles (tibialis anticus and posticus).

The middle cuneiform is directly in front of the scaphoid, behind the second metatarsal, and between the internal and external cuneiform at its sides. It gives attachment to a slip from the tendon of the posterior tibial muscle.

The *external cuneiform* lies in the front row of the tarsal bones, between the middle cuneiform and cuboid. It has the base of the middle (third) metatarsal bone in front and the scaphoid bone behind. It articulates in front with three metatarsal bones—the three middle ones (second, third, and fourth). It gives attachment to the short flexor (flexor brevis pollicis) of the great toe and a part of the posterior tibial (tibialis posticus) muscle.

The *cuboid* (cube-like) bone lies on the outer side of the foot, between the heel-bone (os calcis) behind and the two outer (fourth and fifth) metatarsal bones, which lie in front. It is external to the cuneiform bones and scaphoid.

The lower, or plantar surface, has a deep groove in front, which runs obliquely from without, forward and inward, and lodges the tendon of the long peroneal (peroneus longus) muscle. This bone articulates with the os calcis, external cuneiform, fourth and fifth metatarsal, and sometimes the scaphoid. It gives attachment, in part, to the short flexor of the great toe (flexor brevis pollicis).

The *scaphoid* (skiff-like) bone is situated at the inner side of the tarsus (ankle) in front of the astragalus and behind the three cuneiform bones. It is concave behind where it articulates with the head of the astragalus, and convex in front where it articulates with the three cuneiform bones. It occasionally articulates with the cuboid. On the internal portion of the bone is the *tubercle of the scaphoid*, which gives attachment to a part of the tendon of the posterior tibial muscle.

The *astragalus* (cube, or die) is the second in size of the tarsal bones; the os calcis being first. The astragalus rests upon the front part of the heel-bone (os calcis), and supports the tibia above. It articulates at its inner side with the internal malleolus of the tibia, and at its outer side with the external malleolus of the fibula. It has the scaphoid in front.

On its under surface is a deep groove running obliquely forward and outward, which opposes a similar groove on the upper surface of the os calcis, and thus forms a canal, which is filled by the interosseous ligament of these two bones. No muscles attached.

The calcaneum, or *os calcis* (heel-bone) is situated at the lower and back part of the foot, and transmits the weight of the body to the ground. It projects some distance behind the astragalus, and thus forms a lever for the muscles of the calf of the leg (gastrocnemius and soleus). It articulates above at its fore part with the astragalus, and in front with the cuboid. Its posterior surface gives attachment to the tendo Achillis (tendon of Achilles — the heel-string), which is the common tendon of the gastrocnemius (belly or calf of the leg) and soleus (sole of the shoe, from its shape) muscles. The gastrocnemius is the most superficial. These muscles raise the person upon his toes.

Sometimes the tendon of the plantar (plantaris) muscle unites with the tendo Achillis. For this reason these muscles are sometimes called the triceps extensor pedis (three-headed extensor of the foot). The plantaris is not constant. On the outer side of the os calcis is a rough prominence, which serves as a guide to the surgeon in performing Chopart's operation (removing all the bones of the foot except the os calcis and astragalus. Hey's operation is to remove the metatarsal bones and toes, leaving all the bones of the tarsus (ankle). The inner surface of the calcaneum is deeply concave, for the transmission and better protection of the flexor tendons, plantar vessels and nerves, which run to the sole (plantar surface) of the foot.

The calcaneum (heel-bone) gives attachment to eight muscles. When the plantaris is present there are nine.

The eight muscles are the two already mentioned as forming the tendon of Achilles, two abductors (one of the little toe and one of the great), two flexors (accessorius and brevis digitorum), part of the posterior tibial and one extensor (brevis digitorum — short extensor of the toes).

THE TIBIA.

The tibia is the large bone of the leg. Its name signifies a flute, or pipe. It extends from the ankle to the knee. The upper extremity articulates with the femur (thigh-bone), and is called the head. The head is large, and is expanded at the sides into two projections (tuberosities).

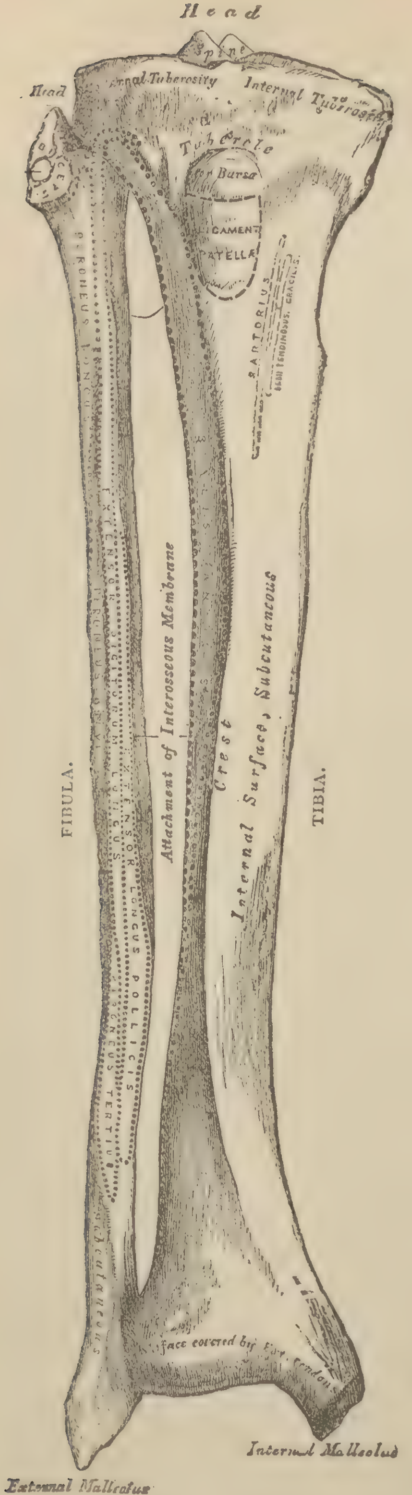
The upper surface of each tuberosity has a large, smooth, and slightly concave face, which articulates with the corresponding condyle of the femur. Between these two faces is a bicuspid (two points) projection,— the spinous process of the tibia,— which serves for the attachment of the two semi-lunar fibro-cartilages interposed between the bones at the knee-joint.

The internal tuberosity is a little longer than the external, because the tibia and femur meet not directly, but at an angle. The femur diverges from the median line of the body as it ascends from the knee toward the hip. In front and behind the spinous process of the tibia is a rough depression for the attachment of the anterior and posterior crucial ligaments. The anterior ligament of the knee is also called the external crucial ligament because it crosses the posterior ligament on the outer side. At the posterior part of the inner tuberosity is a transverse groove for the insertion of the tendon of the semi-membranosus (partly membrane) muscle. Beneath the posterior part of the outer tuberosity is a facet (little face), which articulates with the head of the fibula (the smaller of the two bones which form the leg). Besides the inner and outer tuberosities of the tibia, which articulate at their upper surfaces with the condyles of the femur, there is an *anterior* tuberosity, or tubercle (small prominence), situated in front, and five or six centimeters (about two inches) below the joint which serves for the attachment of the ligamentum patellæ (ligament of the patella, or knee-pan). It is called the tubercle of the tibia. Beneath the ligament of the patella, near its point of attachment to the tibia, is a synovial bursa (a sac containing a glairy fluid), which separates the ligament from the bone.

The tibia at its middle part has nearly the form of a triangular prism, with a sharp border in front called the "shin," or, in technical language, the "crest of the tibia." The inner and posterior surfaces of the shaft are rounded, but the outer surface is more nearly a plane.

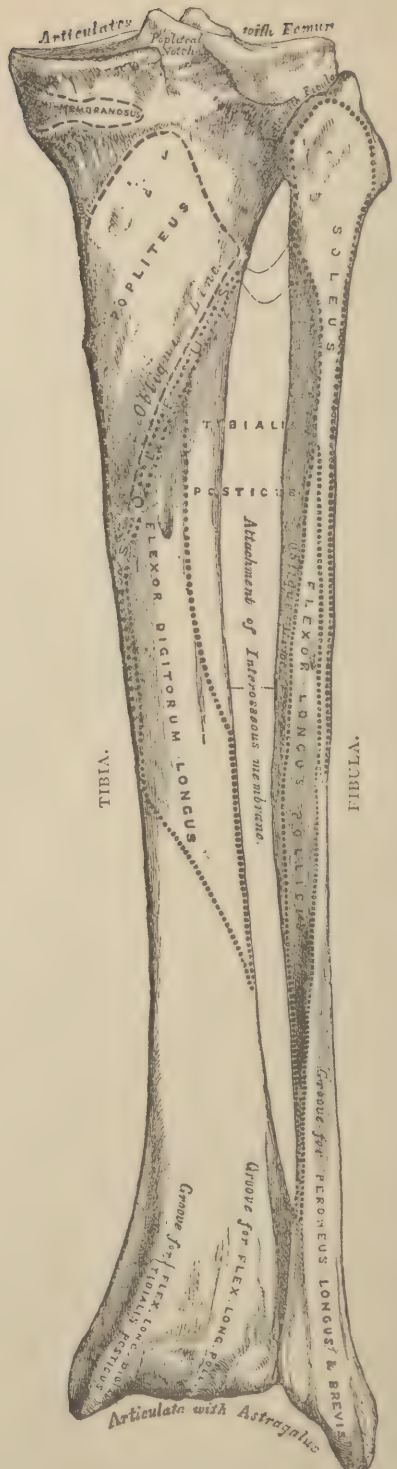
The *lower extremity* of the tibia is prolonged on its inner side into a large process,— the internal malleolus (little hammer). The external malleolus of the ankle is formed by the lower extremity of the fibula

Fig. 62.



BONES OF THE RIGHT LEG —
ANTERIOR VIEW.

Fig. 63.



BONES OF THE RIGHT LEG —
POSTERIOR VIEW.

(clasp or brace). The tendons of the posterior tibial (tibialis posticus), the long flexor of the great toe (flexor longus pollicis), and the long flexor of the toes (flexor longus digitorum), pass over the posterior surface of the internal malleolus in a groove running obliquely downward and inward. The tibia articulates with the fibula at both of its extremities, with the femur at the knee, and with the astragalus at the ankle. It has eleven muscles attached, and one ligament (ligamentum patellæ), which forms the tendon of four other muscles (crureus, vastus internus, vastus externus, and rectus femoris), so that some authors include these four muscles, making fifteen attached to the tibia. The remaining eleven are the biceps, sartorius, gracilis, semi-tendinosus, semi-membranosus, anterior and posterior tibial, long flexor, and extensor of the toes, popliteus, and soleus.

THE FIBULA.

The *fibula* (a brace), called also *peronē*, and *splint bone*, is a long, slender bone situated at the outer side of the leg. Its upper extremity, termed its head, forms a prominent point at the outer side of the knee, especially when the leg is flexed, and gives attachment to the biceps muscle of the leg. It does not form any part of the knee-joint, being attached to the tibia below the joint.

Its shaft is connected with the shaft of the tibia by the interosseous membrane. The lower extremity of the bone forms the external malleolus of the ankle, and articulates with the astragalus.

The fibula articulates with two bones (astragalus and tibia), and gives attachment to nine muscles.

The muscles include three peroneal (longus, brevis, and tertius), two extensors (longus digitorum and proprius pollicis), two flexors (longus pollicis and biceps cruris), the posterior tibial and the soleus.

THE PATELLA.

The patella (knee-pan) is a sesamoid bone, being developed in the tendon of the quadriceps extensor (more frequently called the triceps) muscle. It is situated at the anterior part of the knee-joint, and articulates only with the condyles of the femur. It is somewhat triangular in form, with its base upward and apex downward. The base gives attachment to the three or four (the crureus is intimately connected with the vastus internus) muscles that make up the triceps (vastus

Fig. 64.

THE KNEE-PAN—POSTERIOR SURFACE.

internus, vastus externus, and rectus femoris); and the apex gives attachment to the ligamentum patellæ, which extends to the tubercle of the tibia.

THE FEMUR.

The femur (thigh) is the longest bone in the skeleton. It extends from the knee to the hip-joint, and is the only bone of the thigh. Its shaft is not straight, but curved anteriorly, and in the erect posture of the body is not vertical, but inclined outward as it ascends toward the hip.

At the hips the two femora (plural of femur) are separated by the breadth of the pelvis, which is greater in the female, and varies somewhat in different persons. At the lower extremity the two femora approach the median line of the body. The principal points of the femur for remembrance are the head, neck, two trochanters (rotators), linea aspera, popliteal space, and two condyles.

The head is globular, like the head of the humerus, but differs in two points. It forms the *larger* segment of a sphere, and has a rough depression at its inner part for the attachment of the round ligament (ligamentum teres), which connects the head of the femur with the hip-bone within the acetabulum (cotyloid, or cup-like cavity of the hip).

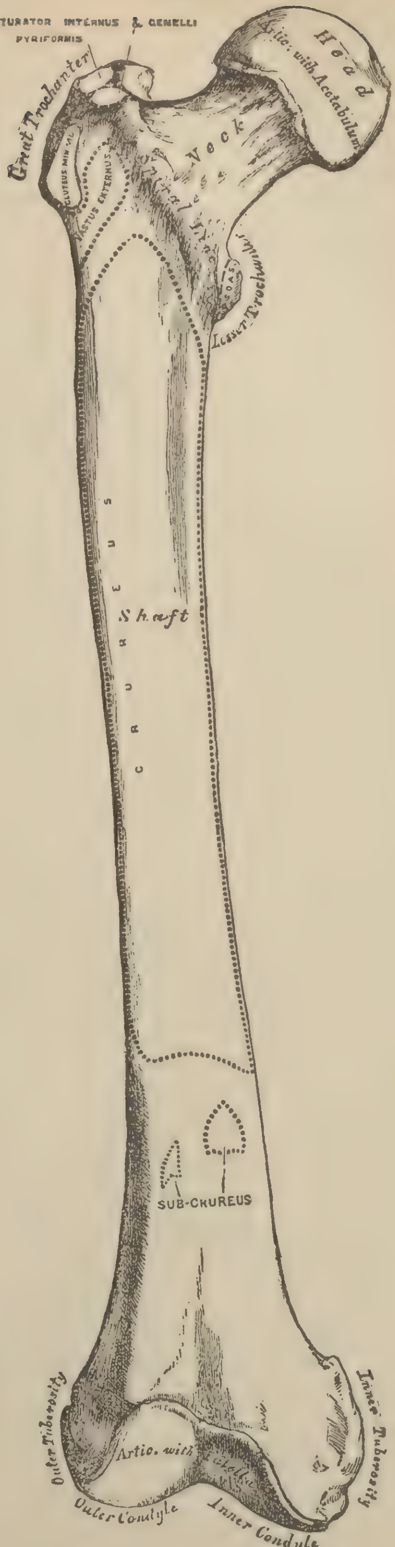
The neck is the constricted portion between the head and the trochanters, and forms an obtuse angle with the shaft. In the adult the angle is about 120°, but grows less by age or debility. As the neck becomes more horizontal it is diminished in length, to enable it to still bear the weight of the body.

The neck extends from the head of the femur to the rough margin on either side (front and back, as the neck is flattened somewhat), which takes the name of intertrochanteric (between the trochanters) line. The intertrochanteric lines extend on either side from one trochanter to the other. The *anterior* intertrochanteric line, which winds

Fig. 65.

RIGHT FEMUR, OR THIGH-BONE—
POSTERIOR SURFACE.

Fig. 66.



RIGHT FEMUR, OR THIGH-BONE—
ANTERIOR SURFACE.

around the base of the neck in front, is also called the *spiral line.* The capsular ligament, which invests the hip-joint, extends, in front, to the spiral line.

The trochanters (rotators, or rollers) are two large processes at the base of the neck of the femur. The one at the outer and upper part of the shaft is called the *great trochanter;* while the other, situated at the posterior and lower part of the base of the neck, is the *small trochanter.*

The great trochanter forms the prominence felt at the outer part of the hip-joint. It gives attachment to 8 muscles, which either *rotate* or move the thigh *outward.* These muscles are 2 gluteal (middle, and least), 2 gemelli (upper and lower), 2 obturator (internal and external), the pyriform, and the quadratus femoris. The gemelli, obturators, and quadratus rotate the thigh outward.

The small trochanter gives attachment to two muscles, the psoas magnus and iliacus. These also rotate the thigh outward, but they also move it forward and inward.

The shaft of the femur is rounded in front, but raised behind into a rough ridge, called the linea aspera (rough line). Near the lower extremity of the bone the linea aspera divides into two lines, which diverge and inclose a triangular space just above the condyles (two large projections outward and backward at the knee). This triangular space behind the knee is called the "popliteal space," over which pass to the leg the popliteal vessels and nerves. The word popliteal relates to the ham; and it is in the popliteal space where the hamstring (tendons of the ham, or thigh) muscles are attached to the tibia and fibula.

The biceps forms the outer hamstring, and four other muscles (semi-membranosus, semi-tendinosus, gracilis, and sartorius) form the inner hamstring.

The lower extremity of the femur is divided by a large notch, posteriorly, into two condyles (knuckles, or knots), the outer and inner condyle. The notch is named from its position,—the intercondyloid (between the condyles) notch. The notch lodges the two crucial ligaments of the knee. The condyles articulate with the tibia. The internal condyle is the longer, on account of the femur meeting the tibia at an angle. If the lower articulating surfaces of the two condyles be placed upon a horizontal plane, or table, and a plumb line be let fall, it will be seen that a vertical line which passes between the condyles below cuts the head of the femur between its upper and inner part, while the main portion of the shaft of the bone lies without the line. The prominences of the condyles at the sides of the knee just above the joint are the inner and outer tuberosities of the femur, and give attachment to the internal and external lateral ligaments of the knee.

The smooth trochlea (like a pulley) surface in front and between the condyles articulates with the patella (knee-pan). The patella is generally considered as one of the bones of the leg, but it articulates only with the femur. The femur articulates with the os innominatum (hip-bone), tibia, and patella. It gives attachment to 23 muscles, 10 of which we have mentioned as being attached to the trochanters. The crureus and sub-crureus are attached to the anterior surface of the shaft; the 2 vast muscles (vastus internus and externus), which form part of the triceps cruris (or quadriceps extensor) to the linea

Fig. 67.

DEVELOPMENT OF THE THIGH-BONE — BY FIVE CENTERS.

aspera (rough line on the posterior surface); 3 adductors (longus, magnus, brevis), the biceps cruris, pectineus, and great gluteal (gluteus maximus) to the posterior surface; and 3 (gastrocnemius, plantaris, and popliteus) to the condyles. The gastrocnemius is also attached by a few fibers to the two divisions of the linea aspera, at the sides of the popliteal space.

The femur is developed from five centers, one for the shaft, one for each extremity, and one for each trochanter. Ossification commences

in the shaft very early in fœtal life, about the sixth or seventh week, and the epiphyses appear in the following order, viz.: for the lower extremity, just before birth; for the head of the bone, at the end of the first year; for the great trochanter, in 3 years; and for the small trochanter, at the approach of puberty. These epiphyses unite with the shaft in the reverse order between the fourteenth and twentieth year of life.

It may be noticed that the epiphyses of the bones of the arm, forearm, thigh, and leg, unite first at the extremity of the bone toward which the nutritious canal for the nutrient artery is directed. These canals in the bones above mentioned are directed *away from the knee*, and *toward the elbow*, and consequently the epiphyses at the elbow unite sooner than those at the shoulder and wrist; and the epiphyses at the hip and ankle-joints unite sooner than those at the knee; or, *latest at the knee, wrist, and shoulder*, as may be seen below.

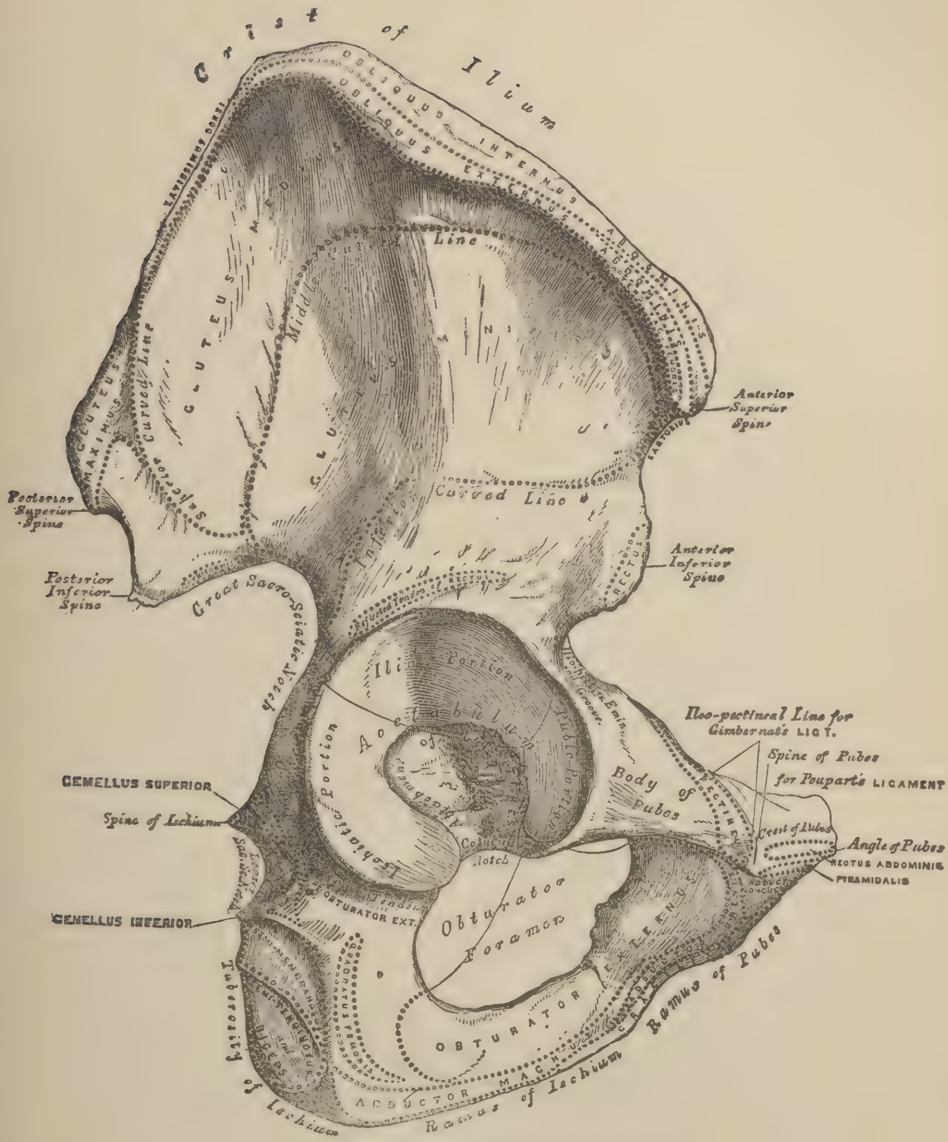
The lower epiphysis of the femur unites about the twentieth year; the upper epiphysis about the eighteenth year; two years later, at the knee. In the tibia and fibula, the epiphyses at the knee (upper extremity) unite about the twenty-fifth year, and the lower (at the ankle), about the twentieth year; five years later at the knee.

In the upper extremity, the epiphysis of the humerus at the shoulder unites at the twentieth year, and at the elbow, the sixteenth; four years later at the shoulder; while the ulna and radius are completely ossified at the elbow (upper extremity) about the sixteenth year, and at the wrist about the twentieth year

THE HIP-BONES.

The two hip-bones are situated at the lower extremity of the trunk. They articulate with each other in front, but are separated posteriorly by the intervention of the sacrum. Each bone is called, also, the "innominate (nameless) bone," or, "os innominatum" (the plural is "ossa innominata"). The hip-bone is large, and very irregular, bearing no resemblance to any known object; hence, nameless. It is sometimes called the aitch (ache) bone, and also coxal (hip) bone. It is so twisted upon itself that the upper portion, called the ilium (turn, or twist), is nearly at right angles with the lower part, which comprises the ischium (ch, pronounced like "k") and pubes. The three portions (ilium, ischium, and pubes) are separate bones until about the fourteenth year of life, and are usually described separately; but the acetabulum (the cavity which receives the head of the femur) and the obturator (or thyroid) foramen are so situated that they belong to the bone *as a whole*,

Fig. 68.



RIGHT HIP-BONE — EXTERNAL SURFACE.

and not to any one part. The acetabulum (vinegar cruse) is a deep hemispherical cup-like (cotyloid) cavity on the outer side of the hip-bone, and is formed by the aid of its three portions. At the anterior margin of the acetabulum is a notch (the cotyloid notch), which is converted into a foramen by the transverse ligament that passes across

it. It is through this foramen that blood-vessels and nerves enter the acetabulum.

The obturator, or thyroid (door-like) foramen, is a large opening through the hip-bone, directly in front of the cotyloid (cup-like) notch, and is formed by the aid of the pubes and ischium (two portions of the hip-bone). The term "obturator" (closed up) is applied to this foramen, because it is (except a small space, at its upper part, for transmitting the obturator vessels and nerves) closed by a membrane, which gives attachment to the internal and external obturator muscles. The muscle (internal obturator) attached to the inner surface of the obturator membrane, passes from the pelvis through the smaller sacro-sciatic (sacrum and ischium) notch to the upper border of the great trochanter; and the external obturator muscle passes behind the neck of the femur to the digital fossa on the inner surface of the great trochanter.

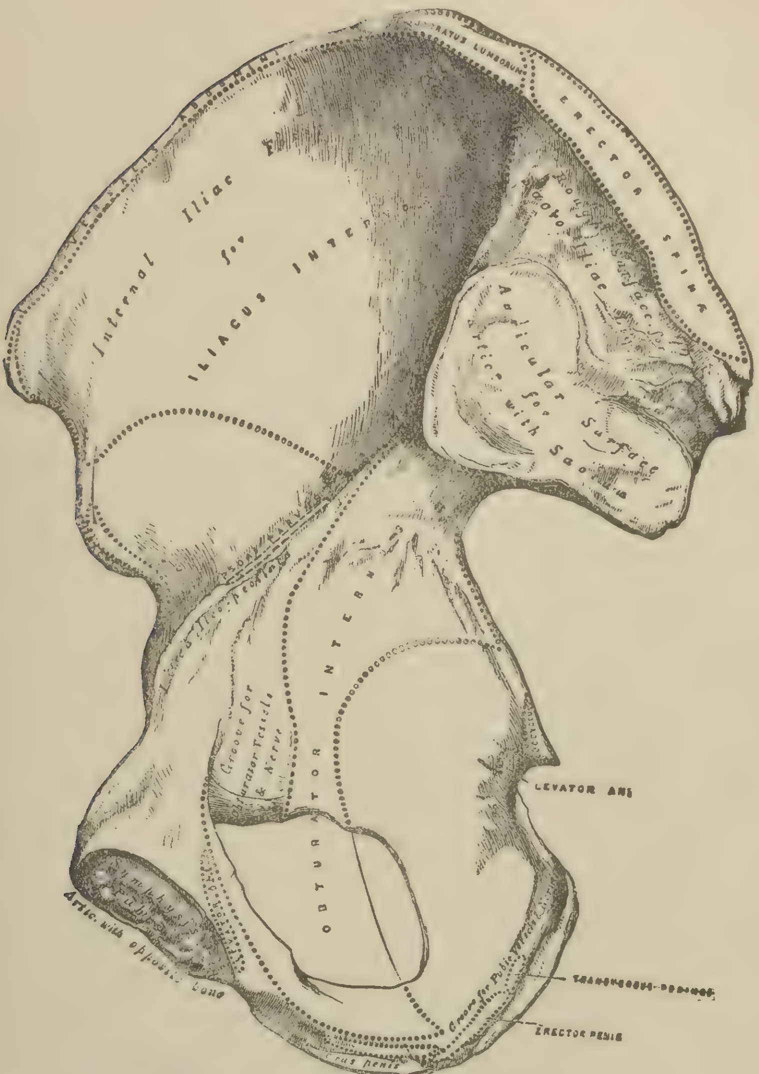
The ilium is the upper and larger portion of the hip-bone (os innominatum). Its principal points to be noticed are the crest, dorsum, spinous processes, iliac fossa, and auricular surface. The **crest of the ilium** is its rounded and most elevated portion. It is sinuous, and forms at its inner lip (it is artificially divided into three lips — outer, middle, and inner) a wavy line, which limners call the line of beauty. To the crest of the ilium are attached seven muscles: three to the outer lip, three to the inner, and one — the internal oblique — to the middle lip. The three muscles that cover the abdomen at the sides, and called, collectively, abdominal muscles, are attached, respectively, to the three lips of the crest of the ilium. The three abdominal muscles just mentioned are the external oblique, internal oblique, and transverse. The latter is most internal, and is attached with two other muscles to the line of beauty (or inner lip). The other two, to the inner lip, are the quadratus lumborum (square of the loins) and erector spinæ (straightener of the spine).

The tensor vaginæ femoris (stretcher of sheath of the thigh) and latissimus dorsi (broadest of the back) are attached with the external oblique to the outer lip of the crest.

The dorsum (back) of the ilium is its outer surface. It extends from the upper and outer margin of the acetabulum to the outer lip of the crest, and gives attachment to the three gluteal muscles (named, from their size, greatest, middle, and least; or in Latin, maximus, medius, and minimus), to the reflected tendon of the rectus of the thigh (rectus femoris), and to a portion of the pyriform muscle (pyriformis).

Authors usually divide the dorsum of the ilium (dorsum ilii) into four parts, or portions, by aid of *three curved lines*, which all terminate at the great sacro-sciatic notch below. These lines are designated as the

Fig. 69.



RIGHT OS INNOMINATUM, OR HIP-BONE — INTERNAL SURFACE.

superior, middle, and inferior curved lines. They are not very distinct, and their chief use is to mark the attachment of the muscles mentioned above. The ilium has four spinous processes: two upon its anterior border and two upon the posterior border. The two anterior spinous processes are the most important, and are designated, by their position, as the upper, and the lower anterior (or, as more frequently called, "anterior superior" and "anterior inferior") spinous process of the ilium.

The anterior superior spinous process is distinctly felt a little above the groin and hip of the person, and is taken as a point of measurement in fracture and dislocations of the femur. This process gives attachment to three muscles and one important ligament. The ligament extends obliquely along the groin to the spine of the pubes, and is called *Poupart's ligament.* The muscles are the sartorius (tailor's muscle,—used in crossing the legs), iliacus (iliac), and the tensor vaginæ femoris (stretcher of the sheath of the thigh), already mentioned in connection with the outer lip of the crest. The anterior inferior spinous process gives attachment to the straight tendon of the rectus femoris muscle. The posterior spinous processes are on the posterior border of the ilium, and give attachment to two muscles (erector spinæ and multifidus spinæ, both attached to the *upper* posterior process), and four ligaments that bind the ilium and ischium to the sacrum (sacro-iliac and sacro-sciatic ligaments).

The *iliac fossa* is a large concave surface which forms the greater part of the internal surface of the ilium, and gives support to the bowels. It is bounded above by the line of beauty (inner lip of the crest), below by the pectineal line (linea-ilio-pectinea), in front, by the anterior border of the ilium, and behind by the sacro-iliac symphysis (articulation or junction of the sacum with the ilium). The iliac fossa is also called the venter (belly) of the ilium. It lodges the iliac (iliacus) muscle.

The auricular surface — or sacro-iliac surface — is that part of the internal surface of the ilium that articulates with the sacrum. A nutrient foramen for arteries is observed upon both surfaces (internal and external) of the ilium, and nearly opposite each other.

The *ischium* (supporter) is the lower portion of the innominate bone, and supports the body in a sitting posture. It is divided into a body and ramus, and some add the tuberosity, as a separate part; but the tuberosity is an indefinite portion situated at the junction of the body with the ramus. The body is nearly vertical, and extends from the acetabulum, which it helps to form, to the tuberosity below. At its upper part, where it joins the ilium and pubis, it is somewhat triangular, and is said to have three surfaces and three borders. The external surface of the body of the ischium is the ischiatic portion of the acetabulum; the internal surface is the lateral boundary of the pelvic cavity; and the posterior surface is continuous with the dorsum (back) of the ilium. The internal surface is continuous with the iliac fossa, but separated from it by the brim of the pelvis. It gives attachment to the obturator internus. On the posterior border of the body of the ischium is the spine of the ischium, which separates the great and small sacro-sciatic notches. (The word sciatic is a contracted form of ischiatic).

The spine gives attachment to a ligament which connects this bone to the sacrum (small sacro-sciatic ligament), and also to three muscles (gemellus superior, coccygeus, and levator ani).

The two notches, one above and the other below the spine of the ischium, are converted into foramina (holes or openings) by the sacro-sciatic (sacrum and ischium) ligaments, and give passage to important nerves, blood-vessels, and muscles. The *pudic* nerve leaves the pelvis through the great sacro-sciatic foramen, and re-enters it through the small sacro-sciatic foramen. The pyriform muscle passes through the great sacro-sciatic foramen, and the internal obturator muscle through the small sacro-sciatic foramen. The *sciatic nerves*, both great and small, pass out of the pelvis through the great sacro-sciatic foramen. The great sciatic nerve is the largest nervous cord in the body. It supplies the muscles of the back of the thigh, leg, and foot.

The tuberosity of the ischium gives attachment to eight muscles. These are the gemellus inferior, biceps of the leg, semi-tendinosus, semi-membranosus, erector penis, quadratus femoris, adductor magnus, and the transverse of the perineum. The perineum forms the floor of the pelvis.

The *ramus* of *the ischium* is the smaller and flattened part which ascends from the tuberosity obliquely upward and inward to meet the descending ramus of the pubes, and helps to form the pubic arch. These two rami — the ramus of the ischium and the descending ramus of the pubes — form an osseous connection between the tuberosity of the ischium and the symphysis pubis (the junction of the two pubic bones in front.)

THE PUBES.

Each *pubic bone* has an angle and two rami (branches). The angle is the most anterior and inner part, and is nearly a right angle. It is formed by the symphysis, which is vertical, and the crest of the pubes, which is horizontal.

Of the rami, one, the "horizontal," runs outward and backward, to meet the ilium and ischium at the acetabulum; the other, the "descending," runs downward, to meet the ascending ramus of the ischium. The *crest* of the pubes extends from the angle horizontally outward to a tubercle called the spine of the pubes, and with the crest of the opposite pubes forms the upper margin of the pelvis in front. Each spine is situated about an inch (nearly three centimeters) from the symphysis pubis, or median line of the body, and distant from its fellow five centimeters (two inches). To the crest are attached four

muscles,—the straight (rectus) of the abdomen, the pyramidal (pyramidalis), and the conjoined tendon of two abdominal muscles (internal oblique, and transverse). On the upper surface of the pubes a sharp ridge runs outward and backward from the spine to the ilium, and marks the brim of the true pelvis. The ridge is called the pectineal, or ilio-pectineal line (linea ilio-pectinea). (Pectineal, from "pecten," a comb, signifies nearly the same as "pubic"). To the pectineal line and upper border of the pubes is attached the pectineal muscle (pectineus), and the psoas parvus (small loin muscle). To the anterior portion of the pubes are attached five muscles — three adductors (longus, brevis, and magnus), the obturator externus, and gracilis. (Some of these are also attached to other parts, and have been mentioned before). To the descending ramus is attached the compressor urethræ, making in all 36 muscles that are attached to the innominate, or hip-bone.

These muscles are divided into four sets; viz., the ascending, descending, internal, and external, each set containing respectively, 10, 15, 5, and 6 muscles. The ascending set is again divided into an anterior and posterior set, 5 each. The anterior ascending set forms the anterior and lateral wall of the abdomen. They are the rectus of the abdomen, the pyramidal, the transverse, and the internal, and external oblique. The posterior ascending set forms the posterior wall of the abdomen. They are the psoas parvus, the quadratus lumborum, multifidus spinæ, erector spinæ, and the latissimus dorsi. Of the 15 in the descending set, 9 are attached to the thigh-bone (femur) and 6 to the bones of the leg. The 9 attached to the femur (the femoral group) are the tensor vaginæ femoris; the gluteus maximus, medius, and minimus; the adductor longus, magnus, and brevis; the iliacus, and the pectineus. The 6 attached to the bones of the leg (the crural group) are the sartorius, rectus femoris, gracilis, biceps flexor cruris, semi-tendinosus, and semi-membranosus.

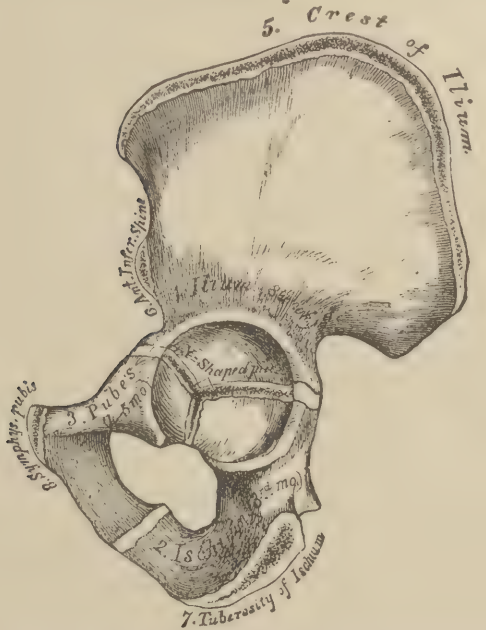
The internal set lie mostly in the floor of the pelvis. They are the coccygeus, levator ani, compressor urethræ, transversus perinei, and erector penis. The external set are the pyriform, the gemellus, superior and inferior, the obturator internus and externus, and the quadratus femoris.

An amputation at the hip-joint divides all the muscles of the external and descending sets, and one — the psoas magnus, which descends from the spinal column to the small trochanter — which is not attached to the hip-bone, making in all twenty-two muscles divided in this operation.

The hip-bone is developed from eight centers of ossification, one

Fig. 70.

By 8 Centres { 3 Primary (Ilium, Ischium, & Pubes) 5. Secondary



The 3 Primary centres unite through Y Shaped piece, about puberty

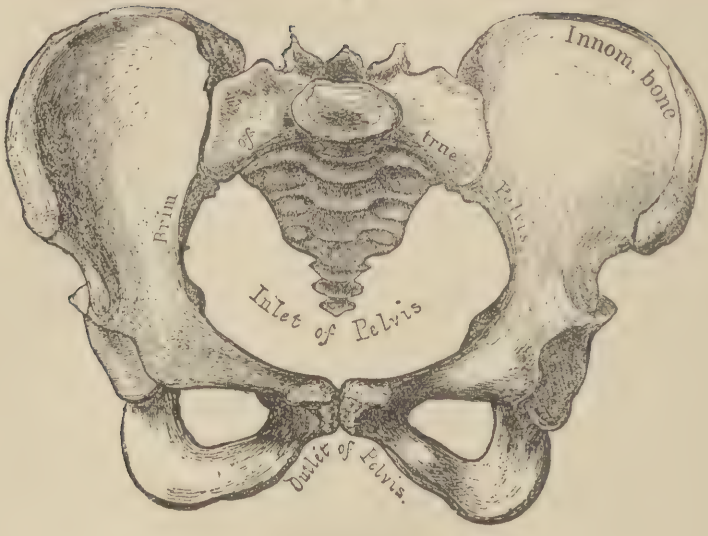
DEVELOPMENT OF THE HIP-BONE.

for each of the following parts: the ilium, ischium, pubes, crest, lower anterior spine (spinous process), symphysis pubis, tuberosity, and a Y-shaped piece at the bottom of the acetabulum. The epiphyses are not all completely ossified till about the twenty-fifth year.

THE PELVIS.

The pelvis occupies the lower part of the trunk, and is a continuation of the abdominal cavity. Its walls serve to support and contain a part of the intestine, the bladder, and the internal genital organs, and form a fixed point for articulation of the lower limbs and the attachment of muscles. Its bony frame supports the vertebral column, and is itself supported by the thigh bones (the "femora"). Its walls are composed of four bones, two of which, the sacrum and coccyx, are situated in the median line behind, and the other two, the hip-bones (ossa innominata), occupy the front and sides of the pelvis. For convenience of description the pelvis is usually divided into two parts by

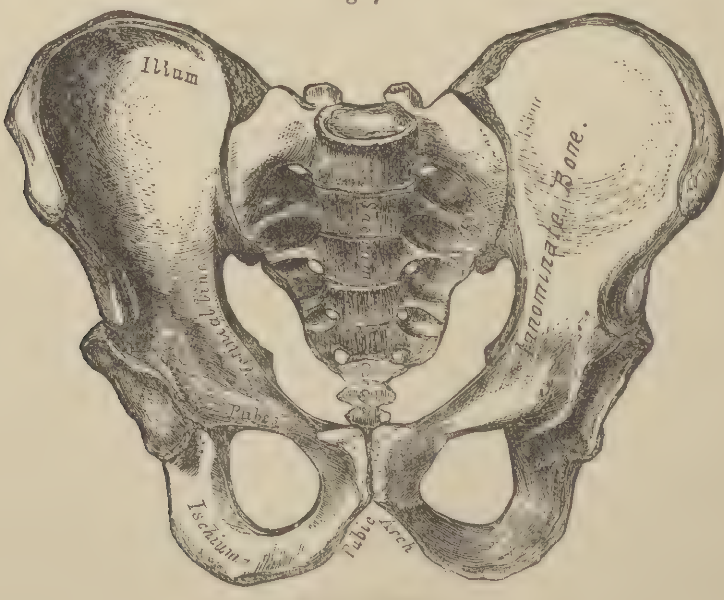
Fig. 71.



FEMALE PELVIS.

a line, or ridge, called the "linea ilio-pectinea" ("line" formed by the "ilium" and pecten, or "pubes"). The *true* pelvis is the part situated *below* the ilio-pectineal line. The *false* pelvis corresponds to the lower part of the abdomen and the illac fossæ (cavities of the ilia).

Fig. 72.



MALE PELVIS.

The true pelvis is open above and below. The upper opening is called the inlet, or "brim" of the pelvis, and the lower opening is called the "outlet" of the pelvis. The axis of the brim represents a line drawn from the umbilicus (navel) to the coccyx; and the direction of the canal through the pelvis is a curve corresponding to the anterior surface of the sacrum and coccyx.

Fig. 73.

VERTICAL SECTION OF THE PELVIS, SHOWING THE DIRECTION OF THE AXIS.

The bones of the pelvis differ in the two sexes. The pelvis of the female is broader and less angular, and the pubic arch has a wider space. In the female the acetabula (the cavities, or sockets, for the heads of the thigh-bones) are farther removed from each other, and the hips, consequently, broader.

ARTHROLOGY (JOINT-STUDY).

ARTHROLOGY generally includes syndesmology (ligament-study), for the reason that ligaments are important elements in the formation of joints. Joints are of two kinds,— movable and immovable. The bones of the skull (cranium) are united by sutures (seams) which do not allow of motion. An immovable joint is termed in anatomical language, "synarthrosis" (joined with). A movable joint is a "diarthrosis" (through, or complete joint). Other joints which do not allow free motion, and yet are not entirely immovable, like the joints between the bodies of the vertebræ and the articulations of the hip-bones with each other and with the sacrum, are said to be mixed joints, and are termed "amphiarthrosis" (both-joints" — relating to diarthrosis and synarthrosis). These terms from the Greek are apparently barbarous, but our work might be considered incomplete, or unscientific, without them. There are yet five or six more kinds, or varieties, of joints.

Schindylesis (by fissure) is where a thin plate of bone is received into a fissure formed by the separation of two plates of other bones as in the reception of the vomer in the fissure between the two upper maxilliary and the two palate-bones.

Gomphosis (nail-condition) is where a conical process is inserted into a socket (alveolus), as the teeth articulate with the jaw.

Arthrodia (joint-form) is a form of joint that admits of a gliding movement, as in the joints of the lower jaw in the glenoid fossæ, and of the radius and ulner, wrist, etc.

Enarthrosis ("condition of joint in" a cavity) is the "ball and socket" joint, like the shoulder and hip.

Ginglymus (hinge) is a joint that admits motion in two directions only, as at the elbow (*i. e.*, the joint formed by the ulna and humerus); also the joint formed at the ankle by the tibia and astragalus, and the joints of the fingers and toes. ("G" is hard in ginglymus, and "n" has the sound of "ng.")

Harmonia (harmony or adjustment) is by apposition of contiguous rough surfaces, like the suture formed by the two superior maxillary bones.

The joints admit four kinds of movement: the gliding, angular, circumduction, and rotation. But as the angular movement may take place in four directions, giving rise to flexion (bending), extension (straightening), *ab*duction (leading from), and *adduction* (leading to or toward the median line, or axis of the body), it is better to drop the term "angular," and reckon seven varieties of motion; viz., gliding, flexion, extension, abduction, adduction, circumduction, and rotation. Circumduction (leading around) is performed when the hand or foot is made to describe the arc of a circle. Rotation is the movement of a bone around its own axis, and the best example is that of the head of the radius, as it rotates upon the radical head of the humerus.

Bone is the fundamental element of all the joints. Besides bone, the immovable joints have interposed a thin layer of fibrous membrane, and sometimes a thin layer of cartilage, but the adjacent margins, or surfaces, of bone, are applied in almost close contract. The mixed joint (amphiarthrosis) is formed by the interposition of tough and elastic fibro-cartilage (a union of cartilage and fibrous membrane), and is sometimes called "synchondrosis" (union by cartilage). In addition to bone, cartilage, and fibro-cartilage, the movable joints (diarthroses) are supplied with ligaments and synovial membrane.

The synovial membrane secretes a fluid called synovia (with egg), which resembles the white of an egg, and serves to lubricate the joints and the sheaths in which tendons play.

There are three varieties of synovial membrane; or, more properly, three situations in which it is placed. When lining a joint it is called "articular" synovial membrane; placed between opposing surfaces as a closed sack, to prevent friction, it is called "bursal" (leathern sack, or bottle); and when lining canals through which tendons glide, "vaginal" (sheath) synovial membrane.

The bursal synovial membrane found beneath the integument which covers the patella, olecranon process, malleolus, and other prominent parts, takes the name of mucous bursa ("bursa mucosa," plural, "bursæ mucosæ") while a similar sack placed between tendons as they play over processes of bone, is called a synovial bursa.

Ligaments (bands) are usually composed of white fibrous tissue, which is pliant and flexible, but firm and inextensible. They bind the bones firmly together.

Several ligaments connected with the spinal column and larynx are composed of yellow elastic tissue. The yellow elastic ligaments are the ligamentum nuchæ (ligament of the nape of the neck), the ligamenta subflava, which connect the laminæ (plates) of the vertebræ, and the true vocal cords. Ligaments that invest the whole joint like a cap are termed capsular (small box, or case) ligaments.

Cartilage is usually of a bluish white color, firm and highly elastic.

Temporary cartilage is the early substitute for bone, which replaces it in the adult. Permanent cartilage is found in the joints, at the extremities of the ribs, in the pavilion or pinna of the ear, in the nose, eyelids, Eustachian tube, larynx, trachea, etc.; and when once divided or destroyed does not grow again or unite. All cartilage, except that which invests articulating surfaces of bone, is surrounded by a membrane called the perichondrium (around cartilage). The perichondrium is analagous to the periosteum, which surrounds bones. *Inter-articular* (between the joint) *fibro-cartilage* is a fibro-cartilaginous plate interposed between the articular cartilages of the wrist, knee, lower jaw, pubes, the joints formed by the sacrum and coccyx, and by the clavicle with the sternum and scapula.

The interarticular fibro-cartilages are free on both surfaces, while the articular cartilages are free on one surface only. The interarticular cartilages are held in position by having their borders connected to the surrounding ligaments. They serve, like a "washer" in machinery, to prevent compression, deaden the intensity of shocks, and facilitate gliding movements.

There are 28 groups of joints. They may be enumerated as follows, viz.:—

1. Temporo-maxillary (temporal bone and lower jaw).
2. Cranio-spinal (occipital bone, with atlas and axis).
3. Atlo-axoid (atlas and axis).
4. Vertebral (vertebræ with each other).
5. Costo-vertebral (ribs and vertebræ).
6. Chondro-sternal (costal cartilages and sternum).
7. Ilio-sacral (ilium and sacrum).
8. Ischio-sacral (ischium and sacrum).
9. Coccygeo-sacral (coccyx and sacrum).
10. Inter-pubic (between the pubes).
11. Sterno-clavicular (sternum and clavicle).
12. Scapulo-clavicular (scapula and clavicle).
13. Inter-scapular (parts of the scapula with each other).
14. Humero-scapular (humerus and scapula, shoulder-joint).
15. Humero-ulnar (humerus and ulna; also with the orbicular ligament).
16. Radio-ulnar (radius and ulna).
17. Carpal (wrist-joint,—connecting three of the upper row of carpal bones [schaphoid, semi-lunar, and cuneiform] with the radius, and indirectly through the intervention of the triangular fibro-cartilage with the ulna).

18. Intercarpal (connecting the carpal bones with each other).

19. Carpo-metacarpal (bones of the carpus with the metacarpal bones).

20. Intermetacarpal (four metacarpal bones, with each other,— the first metacarpal not being connected with the others).

21. Phalangeal (connecting the phalanges [ranks or rows] with each other; *i. e.*, the first row with the second, and the second with the third, at the ends of the fingers and toes. The phalangeal articulations also connect the first row [phalanx] of the hand, or foot, with the phalanx that forms the palm and instep, making fifty-six joints in the hands and feet that are similar). These joints are ginglymoid (hinge-like), and have each an anterior and two lateral ligaments.

22. Intermetatarsal (four metatarsal bones with each other; the first not coming in contact with the second).

23. Tarso-metatarsal (bones of the tarsus with the metatarsal).

24. Intertarsal (tarsal bones with each other).

25. Tarsal (ankle-joint, connecting the astragalus with the tibia and fibula).

26. Tibio-fibular (tibia with the fibula).

27. Tibio-femoral (tibia with the femur, knee-joint).

28. Coxo-femoral (hip-bone with the femur, and forming the hip-joint).

Synarthrosis is a joint, or union of bones, without motion. It has three varieties: the suture (seam), schindylesis (by fissure), and gomphosis (tooth in its socket).

Amphiarthrosis is a union with slight motion, or an incomplete joint. It is a union by the intervention of fibro-cartilage, and in the pelvis takes the name of symphysis (union, or "growing together").

Diarthrosis is the complete, or perfect joint. This joint has four varieties: arthrodia (gliding-joint), enarthrosis (ball and socket), ginglymus (hinge-joint), and diarthrosis rotatorius (pivot-joint). The head of the radius in the small sigmoid cavity of the ulna (held in place by the orbicular ligament), and the rotation of the atlas around the odontoid (tooth-like) process of the axis, are the only examples of pivotal articulation (diarthrosis rotatorius, or lateral ginglymus). Twelve joints in the body have one or more interarticular fibro-cartilages. These are two of the jaw (temporo-maxillary), two of the knees (tibio-femoral), each joint having two intervening fibro-cartilages (the internal and external semi-lunar), one of the pubes, two at the wrists (carpal), one between the sacrum and coccyx (coccygeo-sacral), two (not constant) at the union of the scapula and clavicle (scapulo-clavicular or acromio-clavicular), and two between the clavicle and sternum (sterno-clavicular),

making twelve joints, with fourteen intervening cartilages; or ten joints (when the intervening cartilage is absent between the acromion process and clavicle) with twelve interarticular fibro-cartilages.

These twelve joints can be best remembered by their situation,—one at the apex of the sacrum, one at the pubes, one at each condyle of the jaw, one at each end of each clavicle, and one at each wrist and knee.

1. TEMPORO-MAXILLARY JOINT.

The ligaments of the first group (*temporo-maxillary*) are the capsular, stylo-maxillary, and two lateral (internal and external). This joint has usually two synovial membranes, one above, the other below the fibro-cartilage. Sometimes the intervening fibro-cartilage is perforated, and the synovial membranes are then continuous with each other.

Fig. 74.

TEMPORO-MAXILLARY ARTICULATION.

The capsular ligament extends from the circumference, or margin, of the glenoid fossa (or cavity) to the neck of the condyle, completely covering the joint. The stylo-maxillary ligament connects the styloid process of the temporal bone to the angle of the jaw, and separates the parotid gland from the submaxillary gland. The internal lateral ligament connects the spinous process of the sphenoid with the internal

surface of the ramus (branch) of the jaw. On account of this connection, the first group might be called the spheno-temporo-maxillary. The external lateral ligament connects the outer surface of the neck of the condyle with the zygoma (zygomatic process of the temporal bone).

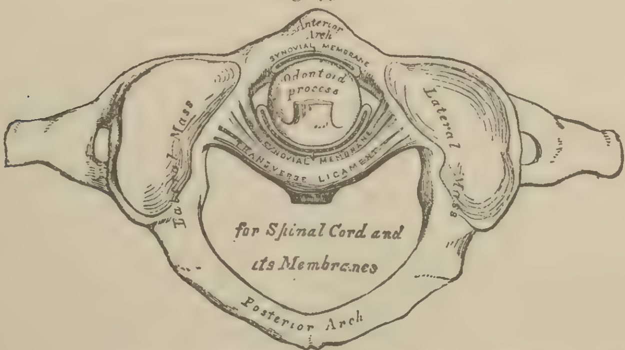
2. CRANIO-SPINAL JOINT.

The *cranio-spinal* articulation includes the ligaments that bind the occipital bone to both the atlas and axis. Two capsular ligaments surround the condyles of the occipital bone and cups of the atlas; two anterior, one posterior, and two lateral connect the occipital bone with the atlas (called "occipito-atloid"); and three check ligaments connect the occipital bone with the odontoid (tooth-like) process of the axis, and are sometimes called odontoid ligaments. (The "occipito-axiod" of authors is a prolongation of one of the vertebral ligaments, and may be omitted.) The check ligaments are attached, two to the inner sides of the condyles of the occipital bone, serving to limit the extent of rotation of the head, while the third is attached to the anterior margin of the foramen magnum, and is sometimes called the suspensory ligament.

3. ATLO-AXOID JOINT.

The atlas and axis are bound together by two capsular, two anterior, a posterior, and a transverse ligament. There are, also, four synovial membranes between these two bones; one lines the surface of

Fig. 75.



ARTICULATION OF THE ATLAS AND AXIS.

each capsular ligament, one is between the odontoid process and anterior arch of the atlas, and the other is behind the odontoid process, and

separates it from the transverse ligament. The transverse ligament has also been called the cruciform, or crucial ligament, because it sends a small band upward to the basilar process of the occipital bone, and another downward to the root of the odontoid process. The transverse ligament connects the opposite sides of the atlas, and separates the spinal foramen from the odontoid process, which occupies the anterior arch of the atlas.

4. THE VERTEBRAL JOINTS.

The vertebral ligaments include eight kinds: three connect the bodies of the vertebræ; two, the spinous processes; and one, each, the laminæ, articular processes, and transverse processes.

The *anterior common ligament* joins the bodies of the vertebræ in front, from the axis to the sacrum. The *posterior common* extends along the posterior surfaces of the bodies of the vertebræ from the occipital bone to the sacrum, and includes the "occipito-axoid" of some authors. The posterior common ligament is situated within the spinal canal, and separates the bodies of the vertebræ from the dura mater of the spinal cord.

The *intervertebral substance* (called, also, "intervertebral fibrocartilage") and intervertebral disk (plate between the vertebræ) is interposed between the adjacent surfaces of the bodies of the vertebræ from the axis to the sacrum. There are twenty-three of these disks, and they form altogether nearly one fourth of the length of the spinal column, the bodies of the vertebræ making up the other three fourths. They vary in size, shape, and thickness, in different parts of the spine. Their size is greatest in the lumbar region, corresponding to the bodies of the vertebræ. They are thicker in the lumbar and cervical region, where they give greater pliancy than is allowed in the dorsal region of the spine. In the dorsal region they are connected to the heads of the ribs which articulate with two vertebræ, by means of the interarticular ligament.

The *ligamenta subflava* (yellow ligaments, composed of yellow elastic tissue) connect the various laminæ with each other, from the axis to the sacrum. There are 23 of these also. Their great elasticity serves to preserve the upright posture, and counteract the efforts of the flexor muscles of the spine.

The *capsular ligaments* connect the articular processes of the vertebræ; and as each vertebra has 4 articular processes, we have 46 of these capsular ligaments below the atlo-axoid articulation,

which we have already described. Each capsular ligament is lined on its inner surface with synovial membrane. The last vertebra articulates with the sacrum, and requires two capsular ligaments.

The ligaments connecting the spinous processes with each other are called respectively "*inter-spinous*" (between the spines) and "*supra-spinous*," (above, or behind the spinous processes). The supra-spinous is a compound ligament extending from the spine, or spinous process of the vertebra prominens (seventh), to the sacrum. Its deeper fibers connect only contiguous spinal processes, while the more superficial fibers connect three or four of the adjoining spines.

The *inter-spinous ligaments* connect the adjacent margins of the spinous processes in the dorsal and lumbar regions with each other. The intertransverse ligaments are small, and sometimes wanting in the cervical region. They connect the transverse processes with each other.

In flexion of the spinal column forward the anterior common ligament is relaxed; while the posterior common, the yellow elastic, the spinous, and the posterior fibers of the intervertebral disks are all put upon the stretch, and the intervertebral disks are compressed in front. Flexion of the column backward is limited by the anterior common ligament and by the approximation (or approach) of the spinous processes. To sum up the vertebral ligaments, we have the anterior common, posterior common, the intertransverse, interspinous, intervertebral (disks), the supra-spinous, capsular, and ligamenta subflava.

5. COSTO-VERTEBRAL JOINTS.

The ribs connect with the vertebræ at two points; one at the head of the rib, with one or two bodies of the vertebræ (the first rib, and also the eleventh and twelfth articulate with one), the other connecting the neck and tubercle of the rib with the transverse process of the vertebra Each has a capsular ligament surrounding the joint, and the former, at the head of the rib, has an interarticular ligament, which divides the joint into two cavities, and each is lined by a separate synovial membrane. The joints at the heads of the first, eleventh, and twelfth ribs, which articulate with the body of a single vertebra, do not have an interarticular ligament, and consequently but one synovial membrane. There are three or four other ligaments connected with the union of the ribs with the vertebræ, but we deem it unnecessary to mention them here.

6. CHONDRO-STERNAL JOINTS.

The cartilages (χονδροί [chondroi]) of the true ribs, except the first, are united to the sternum in middle life by arthrodial joints and synovial membranes, and the articulations (joints) are called *chondro-sternal.* The cartilage of the first rib is united to the sternum *directly*, as the remaining six are also generally found in old age. The second has an interarticular ligament, and two synovial membranes like some of the joints at the head of the rib. The third has also two synovial membranes; the rest, one each, making eight synovial cavities between the costal cartilages and ribs on each side of the body. The ligaments of these joints are the anterior, and posterior costo-sternal (more properly chondro-sternal), costo (or chondro) xiphoid, and the capsular.

7. ILIO-SACRAL ARTICULATION.

The ilio-sacral (or sacro-iliac, union of the sacrum and ilium) articulation has two ligaments — the anterior and posterior sacro-iliac ligaments.

8. ISCHIO-SACRAL CONNECTION.

This joint is ligamentous only, since the bones connected are not contiguous. The connection is made by means of two ligaments (the greater and less sacro-sciatic, connecting the sacrum and ischium), which convert the sacro-sciatic notches into foramina

9. COCCYGEO-SACRAL JOINT.

This joint is similar to that between the vertebræ. It has an interarticular fibro-cartilage and two ligaments — the anterior and posterior sacro-coccygeal.

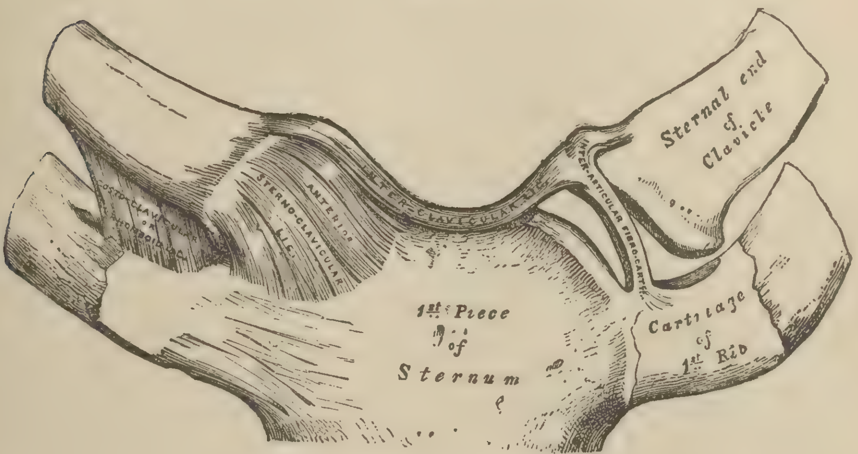
10. INTER-PUBIC JOINT.

This joint has an intervening fibro-cartilage and four ligaments — the anterior, posterior, superior, and inferior (or sub-pubic).

II. STERNO-CLAVICULAR JOINT.

The sternum and clavicle form an arthrodial (gliding) joint; and the same is true of the clavicle at its acromial end. Both joints have an interarticular fibro-cartilage. The sterno-clavicular ligaments are

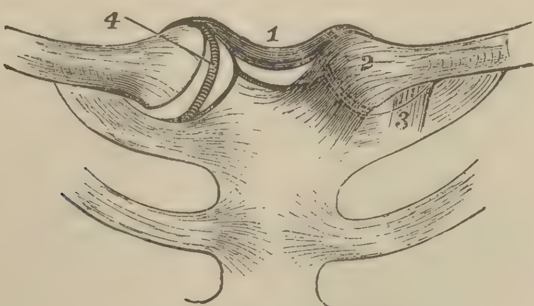
Fig. 76.



STERNO-CLAVICULAR ARTICULATION.

the anterior and posterior sterno-clavicular, inter-clavicular (extending across the upper border of the sternum from one clavicle to the other), and costo-clavicular (or rhomboid). The latter extends obliquely between the sternal end of the clavicle, above, and the first rib below, and has the form of a rhombus (an equilateral, oblique-angled parallelogram).

Fig. 77.



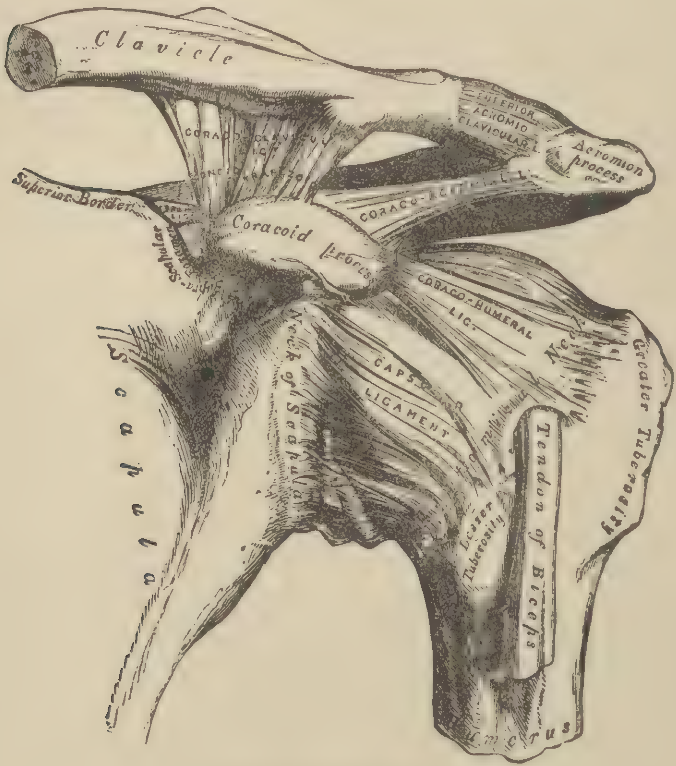
STERNO-CLAVICULAR LIGAMENTS.

1. Interclavicular Ligament.
2. Anterior Sterno-Clavicular Ligament.
3. Costo-Clavicular Ligament.
4. Interarticular Fibro-Cartilage.

12. SCAPULO-CLAVICULAR JOINT.

This joint has four ligaments — upper and lower acromio-clavicular (connecting the clavicle with the acromion process of the scapula), trapezoid, and conoid, ligaments. The two latter are coraco-clavicular (connecting the clavicle with the coracoid process of the scapula).

Fig. 78.



THE LEFT SHOULDER JOINT.

This joint has sometimes a more or less complete interarticular fibro-cartilage. There are one or two synovial membranes, depending upon the existence, or absence, of the intervening fibro-cartilage.

13. INTER-SCAPULA CONNECTIONS.

This group is *not properly a joint*, but two ligamentous unions, connecting parts of the scapula (shoulder-blade) with each other. The coraco-acromial ligament connects the coracoid and acromion processes,

and completes the vault formed by these processes for the protection of the head of the humerus. The transverse ligament of the scapula runs across the upper border of the scapula, near the coracoid process, and converts the supra-scapular (above the scapula) notch into a foramen which transmits the supra-scapular nerve and blood-vessels.

14. HUMERO-SCAPULAR JOINT.

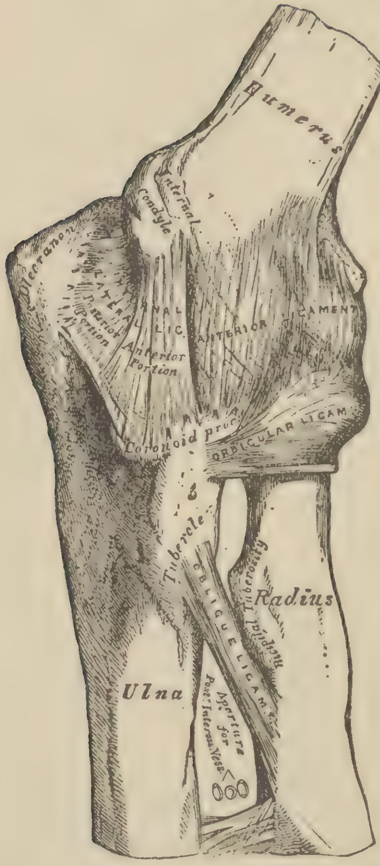
The shoulder joint is enarthrodial (ball and socket joint), and allows the freest motion of all the numerous joints. It is protected above and in front by an arched vault, formed by two strong, bony processes (the acromion and coracoid of the scapula), and the coraco-acromial ligament connecting them. The ligaments of the shoulder joint are the *capsular*, *coraco-humeral*, and *glenoid*. The glenoid ligament surrounds the margin of the glenoid cavity of the scapula. It deepens the cavity, and serves to protect the edges of the bone. The coraco-humeral (connecting the coracoid process of the scapula with the humerus) ligament blends at its outer part with the upper part of the capsular ligament, which it serves to strengthen. It extends from the anatomical neck of the humerus to the coracoid process of the scapula.

The capsular ligament completely encircles the joint. It is attached at one extremity to the anatomical neck of the humerus, and at the other to the circumference of the glenoid cavity, inclosing the glenoid ligament. The synovial membrane lines the inner surface of the capsular ligament, and is reflected upon the tendon of the biceps muscle, which passes through the joint without entering the synovial cavity.

15. HUMERO-ULNAR JOINT.

The *humero-ulnar* articulation (elbow joint) is formed by articulation of the humerus with the greater sigmoid cavity of the ulna and head of the radius, although none of its ligaments are attached directly to the radius, but connect the humerus with the ulna and obicular ligament, which latter surrounds the head of the radius, and thus binds it to the ulna. The elbow joint is ginglymoid (hinge-like). Its ligaments are the anterior, posterior, internal lateral, and external lateral. The posterior ligament connects the olecranon process with the posterior surface of the humerus; the anterior connects the anterior portion of the humerus and inner condyle with the orbicular ligament and coronoid process; the external lateral ligament connects the

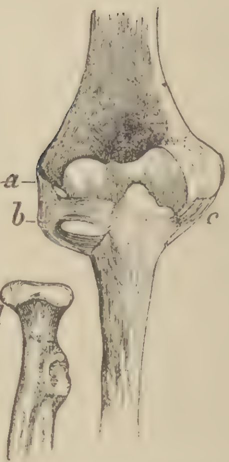
Fig. 79.



LEFT ELBOW JOINT.

Fig. 80.

a. External lateral ligament.
b. Orbicular or annular ligament.



HEAD OF THE RADIUS, REMOVED FROM THE ORBICULAR LIGAMENT.

external condyle with the orbicular ligament; and the internal lateral connects the internal condyle with the olecranon process (by the posterior portion of the ligament) and (by its anterior portion) to the inner margin of the coronoid process of the ulna.

The synovial membrane covers the margin of the articular surface of the humerus (the trochlea surface and radial head), lines the coronoid and olecranon depressions, is reflected over the inner surface of the ligaments, and dips down between the smaller sigmoid cavity and head of the radius.

16. RADIO-ULNAR JOINTS.

The *radio-ulnar* articulations connect these bones (radius and ulna) at both extremities, and also the two shafts. The upper extremities are connected by the orbicular (sometimes called "annular") ligament, which surrounds (with the aid of the smaller sigmoid cavity of the ulna) the head of the radius, and retains it in firm connection with the cavity. The two shafts are connected by two ligaments,—the oblique (or round), and "interosseous" membrane. The round, or oblique, is sometimes wanting. It extends obliquely downward and outward from the base of the coronoid process of the ulna to the shaft of the radius, a little below the bicipital tuberosity. The interosseous ligament is an aponeurotic membrane, connecting the external border of the ulna with the internal border of the radius. It serves, also, as a surface for the attachment of muscles. It is deficient above, adjoining the oblique ligament, and allows passage to the posterior interosseous vessels. The lower extremities of the radius and ulna are connected by the "radio-ulnar" ligaments (anterior and posterior).

A triangular fibro-cartilage, situated between the end of the ulna and the wrist-bones, separates this joint (the radio-ulnar near the wrist) and its synovial membrane from the wrist-joint; but sometimes the two joints (wrist and radio-ulnar) communicate through an opening in the fibro-cartilage.

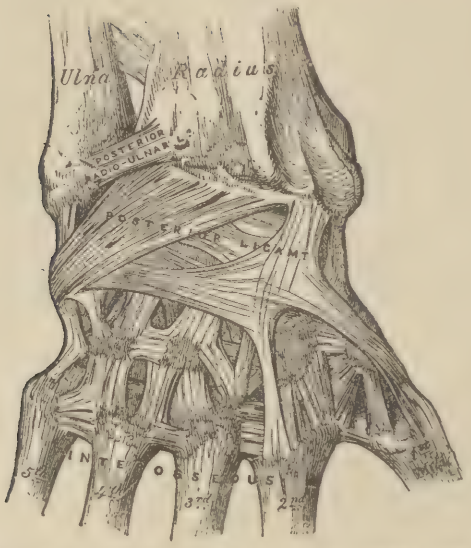
17. CARPAL JOINT.

The wrist (carpal) joint has four ligaments — anterior, posterior, and two (internal and external) lateral. The synovial membrane lines the under (or carpal) surface of the triangular fibro-cartilage, and is reflected on the inner surface of the ligaments that surround the joint. The wrist-joint is covered by the tendons of the muscles that run from the forearm to the hand. The flexors are in front.

18. INTER-CARPAL JOINTS.

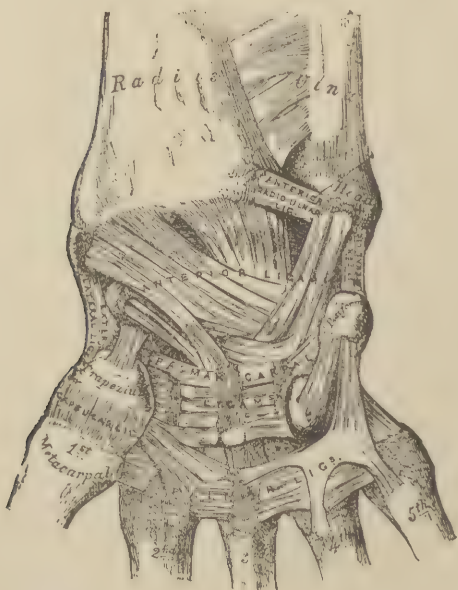
The pisiform bone is joined to the cuneiform by a separate arthrodial (gliding) joint. The cuneiform, semilunar, and scaphoid (bones in the radial or upper row) are joined by two dorsal, two palmar, and two interosseous ligaments. The four bones of the second row are also joined by dorsal, palmar, and interosseous ligaments; and the two rows are joined together by ligaments similar to those of the elbow and wrist — anterior, posterior, and two lateral (internal and external).

Fig. 81.



LIGAMENTS OF THE WRIST AND PALM — POSTERIOR VIEW.

Fig. 82.

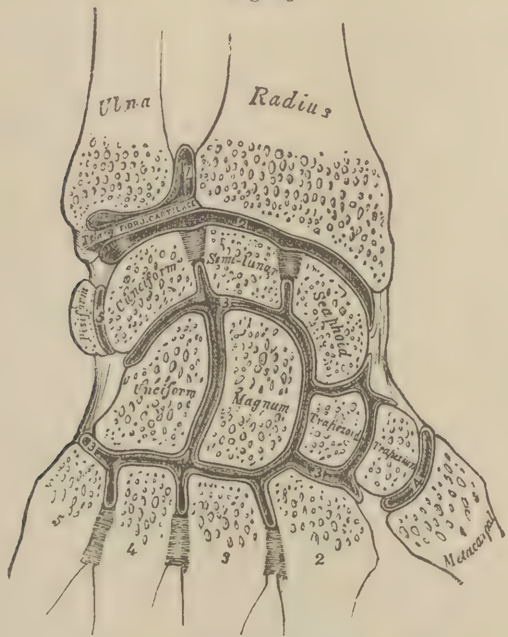


LIGAMENTS OF THE WRIST AND PALM — ANTERIOR VIEW.

19. CARPO-METACARPAL JOINTS.

The joints between the carpal and metacarpal bones are arthrodial (gliding) joints. The first metacarpal bone is united to the trapezium by a capsular ligament and separate synovial membrane; the other metacarpal bones are united to the carpal bones by the aid of dorsal,

Fig. 83.



SYNOVIAL MEMBRANES OF THE WRIST.

palmar, and interosseous ligaments. The interosseous ligaments connect the third and fourth metacarpal bones to the os magnum and unciform. There is one synovial membrane for all the carpo-metacarpal joints, except that of the trapezium with the thumb.

20. INTER-METACARPAL ARTICULATIONS.

The metacarpal bones, all except the first, articulate with each other at both extremities. The carpal (wrist) extremities are bound together by dorsal, palmar, and interosseous ligaments. The interosseous pass between the bones; the dorsal are directed across the back of the hand, and the palmar across the palm. The digital (next the fingers) extremities are connected by a fibrous band,—the transverse ligament,—which passes across them.

21. PHALANGEAL.

These joints have been already described.

22. INTER-METATARSAL JOINTS.

This group so closely resembles the 20th as to require no separate description. The only point of difference is the transverse ligament. It differs from the transverse ligament of the hand, in connecting the *first* with the other metatarsal bones.

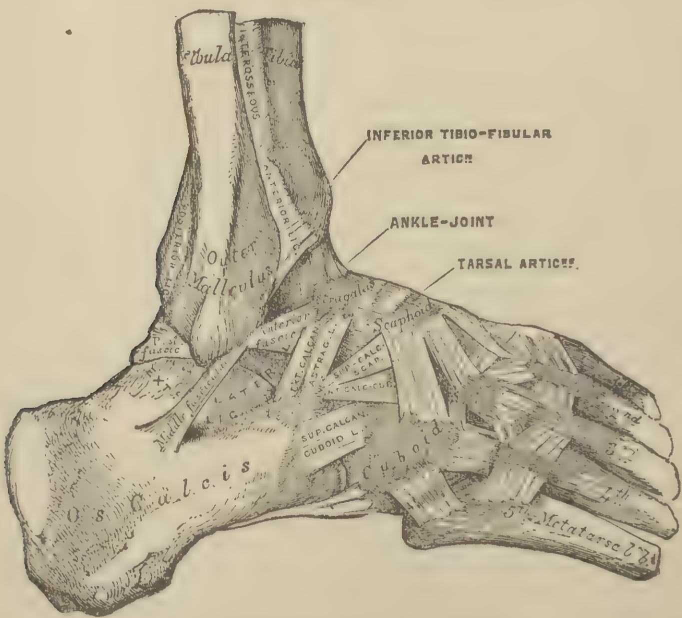
23. TARSO-METATARSAL JOINTS.

This group has dorsal, plantar, and interosseous ligaments, and synovial membranes that extend between the bases of the metatarsal bones.

24. INTER-TARSAL JOINTS.

The seven bones of the ankle (tarsus) are connected by nineteen different ligaments and four synovial membranes. The os calcis (heel-bone) is bound firmly to the astragalus, which rests upon

Fig. 84.



RIGHT ANKLE JOINT—OUTER SIDE.

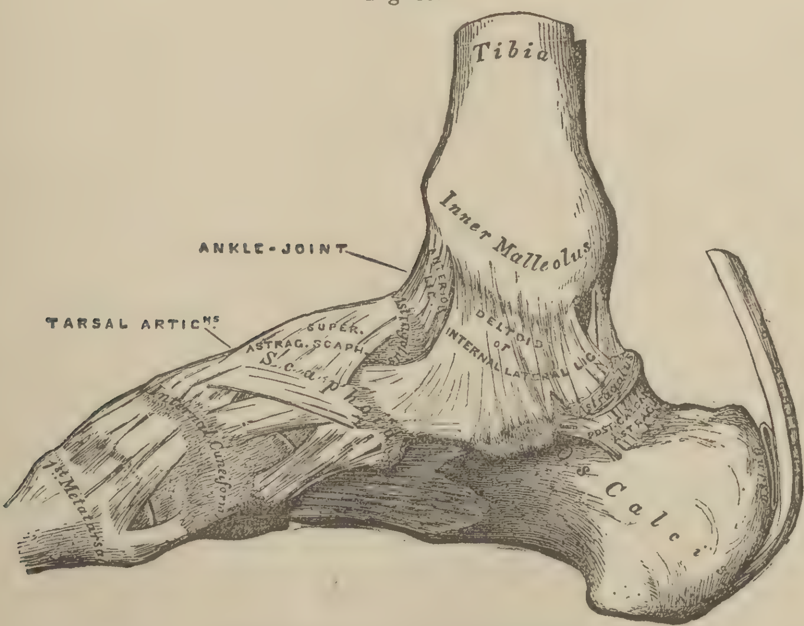
its anterior part by three ligaments — one interosseous, and two calcaneo-astragaloid (posterior and external). The interosseous ligament fills the groove found on the contiguous surfaces of these two bones. The os calcis (or calcaneum) is bound to the scaphoid by two ligaments (superior, and inferior calcaneo-scaphoid); and the same bone is bound to the cuboid by four ligaments (the long, short, superior, and internal calcaneo-cuboid). The long and short calcaneo-cuboid liga-

Fig. 85.

INTEROSSEOUS LIGAMENTS OF THE CUNEIFORM BONES.

ments are plantar (on the sole of the foot), the others dorsal (on the upper part). The long calcaneo-cuboid ligament extends from the under surface of the calcaneum (heel-bone) along the under surface of the cuboid bone to the bases of the metatarsal bones. The second row of tarsal bones are bound together by dorsal, plantar, and interosseous ligaments.

Fig. 86.



RIGHT ANKLE JOINT — INNER SIDE.

25. TARSAL JOINT (Ankle).

The ankle is a ginglymoid (hinge-like) joint. It is formed chiefly by the articulation of the tibia with the astragalus; but the lower end of the fibula rests against the outer side of the astragalus, and forms the external malleolus. The ligaments of the ankle-joint are the ante-

Fig. 87.

LIGAMENTS ON THE PLANTAR SURFACE (BOTTOM) OF THE FOOT.

rior and two lateral (internal and external), the posterior ligament being supplied by the transverse ligament of the tibia and fibula. The internal lateral ligament, on account of its shape, is also called the deltoid (delta-like; *i. e.*, triangular). It connects the internal malleolus with three bones (scaphoid, os calcis, and astragalus). The external lateral ligament of the ankle consists of three distinct parts, called

Fig. 88.

SYNOVIAL MEMBRANES OF THE ANKLE.

fasciculi (little bands). The anterior fasciculus runs from the external malleolus forward to the astragalus; the middle fasciculus runs downward to the os calcis; and the posterior fasciculus backward to the astragalus.

26. TIBIO-FIBULA ARTICULATION.

The tibia articulates with the fibula at both extremities. The superior articulation is an arthrodial joint, and its synovial membrane is sometimes continuous with that of the knee. The superior articulation has two ligaments (anterior and posterior), and the inferior articulation four ligaments. The four lower ligaments are the inferior interosseous, the transverse, an anterior and a posterior ligament.

Besides the upper and lower articulations, the shafts of the tibia and fibula are connected by an interosseous membrane, which extends between the contiguous borders of the shafts, and separates the muscles in front from those on the back of the leg. It is perforated, for the passage of blood-vessels.

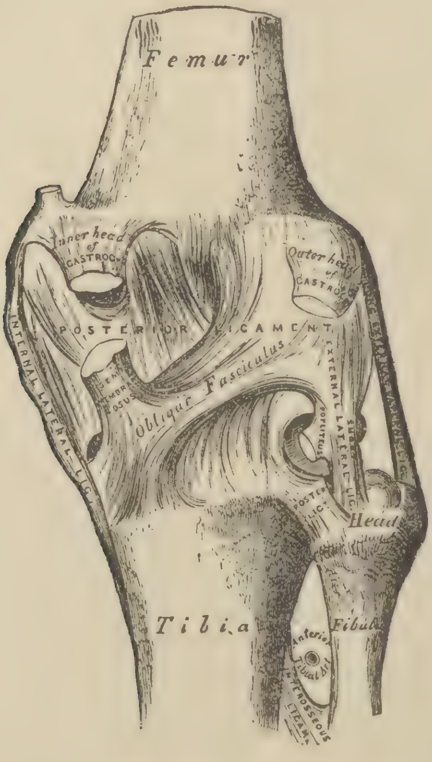
27. TIBIO-FEMORAL JOINT.

The knee-joint (tibio-femoral articulation) is a ginglymoid (hinge-like) joint. It has ten ligaments (five external and five internal ligaments). Some authors give more. The internal ligaments occupy the interior of the joint. The ligamentum patellæ (ligament of the patella) is one of the external ligaments of the knee. It is a continuation of the tendon of the quadriceps (or triceps) extensor muscle, and is sometimes called the *anterior* ligament of the knee, since it supplies the

place of an anterior ligament. Two synovial bursæ are connected with this ligament and the patella; one is interposed between the patella and the skin, and the other beneath the ligament, and separating it from the tibia.

The remaining external ligaments are the posterior (sometimes called the ligament of Winslow), the capsular, and the two lateral (internal and external). The posterior covers the whole of the back part of the joint, and forms part of the floor of the popliteal space, and upon

Fig. 89.

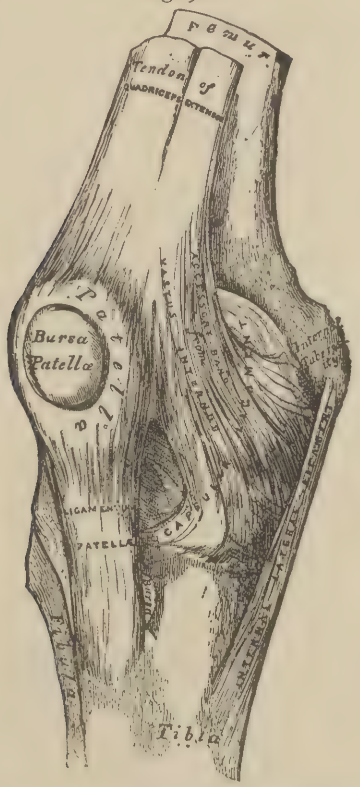


RIGHT KNEE-JOINT — POSTERIOR VIEW.

it rests the popliteal artery. The internal lateral ligament connects the inner tuberosities of the tibia and femur. The external lateral ligament connects the outer tuberosity of the femur with the head and styloid process of the fibula. The capsular ligament completes the investment of the joint. The synovial membrane of the knee is the largest in the body. It forms a large cul-de-sac (blind alley), which extends upward, beneath the tendon of the extensor muscles, four or five centimeters (one or two inches) above the articular surface of the femur, and has

several other processes. Two or three folds of the synovial membrane have been by some authors described as ligaments, and named ligamentum mucosum (mucous ligament), and ligamenta alaria (winged

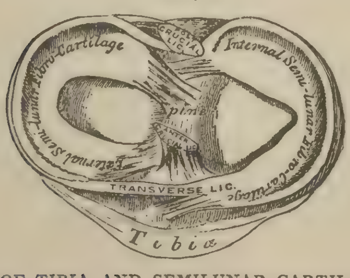
Fig. 90.



RIGHT KNEE-JOINT—ANTERIOR VIEW.

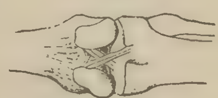
ligaments). Some short fibrous bands which connect the semilunar cartilages with the head of the tibia are by some authors called coronary ligaments. The internal ligaments of the knee include two crucial

Fig. 91.



HEAD OF TIBIA AND SEMILUNAR CARTILAGES.

Fig. 92.



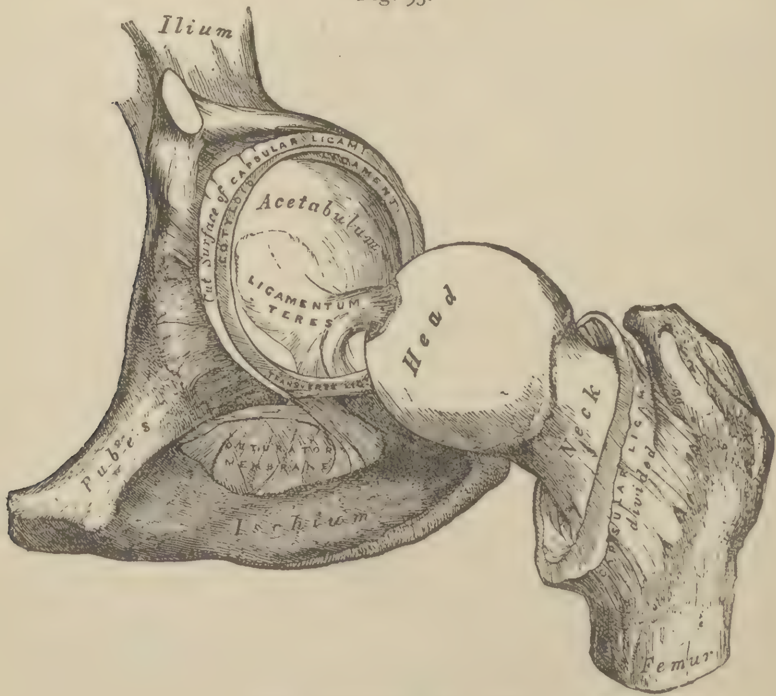
CRUCIAL LIGAMENTS.

(external and internal, or anterior and posterior), two semilunar fibro-cartilages (internal and external), and a transverse ligament. The anterior crucial ligament is attached to the anterior surface of the tibia, *in front* of the spine of the tibia, and the posterior crucial to the posterior surface of the tibia *behind* the spine. The anterior passes to the external condyle (inner and back part), while the posterior crucial passes to the inner (or internal) condyle (outer and fore part), so that the two cross each other in the region of the spine of the tibia. The semilunar fibro-cartilages are interposed between the condyles and the inner and outer articular surfaces of the tibia. The transverse ligament connects the anterior margins of the two semilunar fibro-cartilages.

28. COXO-FEMORAL (HIP) JOINT.

The hip-joint (coxo-femoral) is enarthrodial (ball and socket), and has five ligaments; two are circumferential (around the circum-

Fig. 93.



LEFT HIP-JOINT, LAID OPEN.

ference of the cotyloid cavity), and three are connecting ligaments. The five ligaments of the hip are the capsula, the ilio-femoral, or "Y" ligament, the cotyloid, the transverse, and the ligamentum

teres (round, or polished ligament). The capsular ligament extends from the outer margin of the acetabulum (cotyloid cavity) to the intertrochanteric lines of the femur, covering its head and neck. The ilio-femoral extends from the anterior inferior spine of the ilium to the anterior intertrochanteric line, where it blends with the capsular ligament. The cotyloid is attached to the margin of the cotyloid cavity (acetabulum), and serves to deepen it, and protect the margin of the bone. The transverse extends across the cotyloid notch, and forms it into a foramen for the nutrient vessels to the joint. The ligamentum teres extends from the bottom of the cotyloid cavity to the depression found upon the head of the femur, a little below the center of its articulating surface.

The synovial membrane of the hip-joint is quite extensive. It commences at the margin of the cartilaginous surface of the head of the femur, covers all that portion of the neck invested by the capsular ligament, is reflected upon the internal surface of the capsular ligament, and forms a tubular sheath around the ligamentum teres. Sometimes it communicates with a bursa beneath the tendons of the psoas and iliac muscles.

Articulation and joint are not exactly synonymous, as used in anatomy, although often used interchangeably. Bones are said to articulate (form a *small* joint) whenever they touch each other, but a joint may be composed of two, three, or four bones. The hip and shoulder joints have two bones each; the elbow, knee, and ankle three each; and the wrist-joint, *four* bones. The body has 195 articulations, but not so many joints. A joint may include several articulations (*small* joints).

MYOLOGY (MUSCLE-STUDY).

THE muscles (movers) are the active organs of motion, acting under the influence of the nerves. They are formed of bundles of fibers endowed with the property of contractility. They constitute the lean meat of the body, and are so packed and arranged as to give symmetry of form, rapidity and grace of motion.

There are two kinds of muscular tissue,—the striped, or striated (furrowed), and the unstriated. The muscular tissue marked with striæ (furrows), forms, with one exception (that of the heart), the *voluntary muscles;* and the unstriated muscular tissue is always found composing involuntary muscles. The heart is composed largely of striated fibers, and yet is not generally under the control of the will.

The voluntary muscles are governed by the cerebro-spinal (brain and spinal) system of nerves; the involuntary, by the sympathetic system. The latter carry on the important processes of respiration, circulation, and nutrition, and are called *muscles of organic life.* The muscular fiber of organic life forms the muscular coat of the alimentary canal below the middle of the œsophagus; is found in the posterior wall of the trachea (windpipe); in the bronchi (bronchial tubes); in the ureters and bladder; in the coats of the arteries, veins, and lymphatic vessels; in the iris, the ciliary muscle of the eye; and in many other parts.

Nearly all the muscles that have received names are voluntary muscles, and are governed by the nerves of the cerebro-spinal system. These muscles are all symmetrical with reference to the median plane of the body, and with the exception of four single muscles in the male, and five in the female, are in pairs. The voluntary muscles are, for the most part, attached to the bones, or periosteum (membrane around the bone), and are sometimes called skeletal muscles.

The bundles of fibers which compose a voluntary muscle are themselves composed of bundles of filaments, or fibrils (small fibers), and each filament is inclosed in a delicate sheath, called the sarcolemma (flesh-coat). The whole muscle is invested with a sheath, called the perimysium (around the muscle).

The elementary particles which make up the muscular filament have been called sarcous elements (flesh elements). Each sarcous element is probably a nucleated cell.

The perimysium (sheath around the muscle) generally takes the name of fascia (band or bandage). The fasciæ ("bandagės"—plural of fascia) are divided into superficial and deep fasciæ. The *superficial fascia* is found immediately beneath the skin, over nearly the entire surface of the body, and connects the skin with the deep fasciæ. The *deep fascia* is also called aponeurotic fascia, or aponeurosis ("from, or out of, nerve or tendon." The ancients called every white part "νευρον," or nerve).

An *aponeurosis* is a tendinous expansion, or a firm, white, fibrous membrane, and serves to connect a muscle with a bone, when it is called an aponeurosis of insertion; and to connect one part of a muscle with another, as a central tendon, or as a membranous covering for a muscle, when it is called an aponeurosis of investment. An aponeurosis differs from a tendon only in being flat, or membranous, while the tendon is generally round, or slightly flattened.

The tendons connect the muscles to the bones, and thus transmit their motion to greater or less distances. The end of the muscle attached to the more fixed part is usually considered the "origin," and the other end the "insertion" of the muscle.

In the limbs the fasciæ invest the entire limb, and also give off septa (partitions), which separate the various muscles, and are attached to the periosteum.

The muscles are numerous, but vary somewhat in number according to different authors, some regarding as separate muscles what others regard only as parts, or portions. Gray gives 245 names of muscles, and these include only four single muscles, the rest being pairs and sets, making, altogether, 682 separate, or *individual* muscles. Of these, only 680 belong to either sex separately.

Taking Gray as a basis, we shall omit the following pairs; viz., six small and unimportant muscles of the auricle (external ear), which extend from one part of the auricle to another; three names applied by Albinus to parts of the hyo-glossus; one, which is a part of the spiral lamina of the internal ear; one of the middle ear, which is often regarded as a ligament; one of the thyroid gland, which is not constant; one of the prostate gland, because it is a part of the sphincter ani, and two, which are parts of the splenius, and thus reduce the entire number to 652 muscles, with 230 distinct names.

The four single muscles of the male are the diaphragm, sphincter ani (the internal sphincter), arytenoid, and orbicularis oris, and to these are added in the female the sphincter vaginæ.

The pairs include, among others, 109 pairs which are described in eleven different sets. The eleven sets are the *supra-spinales* (above the spinous processes of the vertebræ), 6 pairs; the *rotatores spinæ* (rotators of the spine), 11 pairs; *lumbricales* (earth-worms), 8 pairs; *levatores costarum* (lifters of the ribs), 12 pairs; *intertransverse* (between the transverse processes), 23 pairs; *interspinales* (between the spinous processes), 13 pairs; *palmar interossei* (between the bones of the palm), 3 pairs; *plantar interossei* (between bones of the sole of foot), 3 pairs; *dorsal interossei* (between bones of back of hand and foot), 8 pairs; *internal intercostal* (between the ribs), 11 pairs; and the external intercostal, 11 pairs.

Besides these eleven sets, there are, by name, 8 pairs of levators (lifters), 13 extensors, 13 flexors, 11 straight ("rectus," plural recti), 6 oblique (obliquus), 5 adductors ("leading toward," or drawing toward the axis, or median plane of the body), 4 abductors ("leading from"), 4 transverse (running across), 4 tensors, 3 each of the gluteal, erectors, depressors, compressors, constrictors, peroneal, sphincters (contractors), saw-like ("serrati," plural of serratus), and scalene (a triangle with unequal sides), and 2 each of the gemelli (plural of gemellus, "twin"), dilators, obturators, biceps, quadrati (plural of quadratus), rhomboid (or rhomboideus), spinales (plural of spinalis), zygomatic, vasti (plural of vastus), palmares (plural of palmaris), pectoral, pronators, supinators, teres, tibiales (plural of tibialis), crico-arytenoid, psoas, pterygoid, and pyramidal.

The muscles vary greatly in form and size, and take their names from their use, shape, dimensions, direction, attachments, etc.

Of the 230 names of sets, pairs and single, 42 are muscles of the cranium and face, 52 of the lower extremities, and 46 each in the neck, trunk, and upper extremities. The lumbricales and dorsal interossei are situated in both the hands and feet, and are enumerated twice.

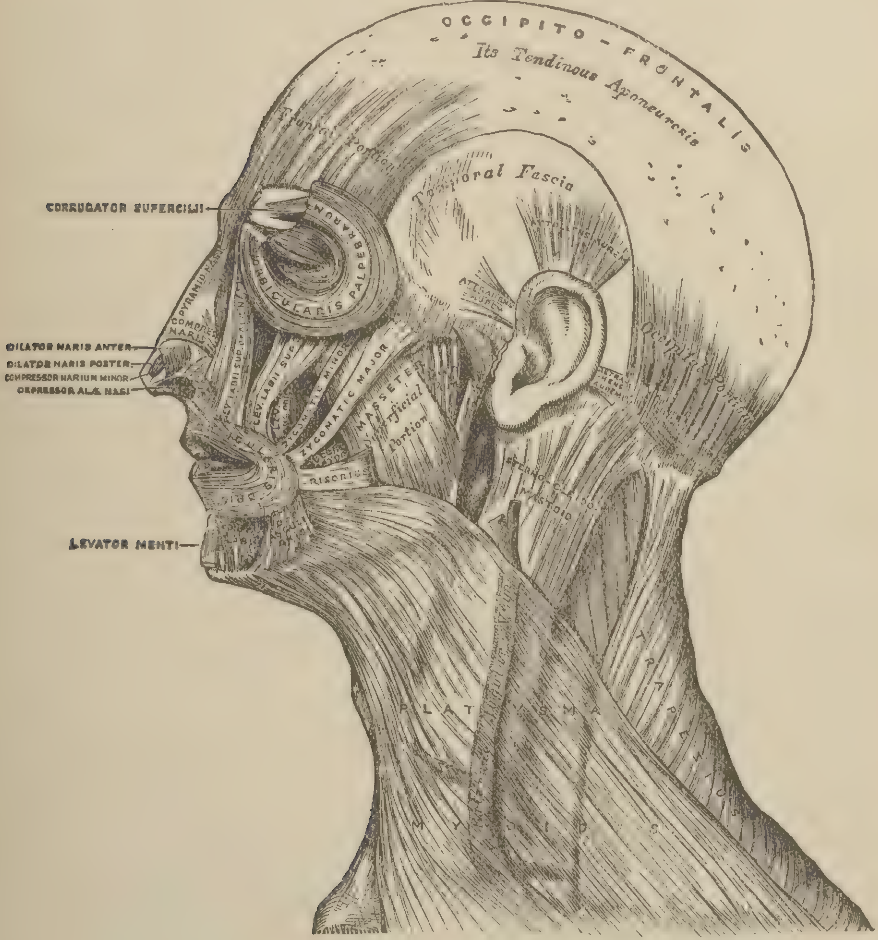
DIFFERENT NAMES OF THE SAME MUSCLE.

The "abductor indicis" of some authors is the "first dorsal interosseous" of the hand. The "triceps extensor cruris" of authors is the collective name of three muscles — the two vasti and crureus. The "quadriceps extensor" includes the same three muscles as the triceps, together with the rectus femoris. The depressor alæ nasi is sometimes called the myrtiformis (form of a myrtle leaf), and, by some authors, depressor labii superioris alæque nasi. The depressor anguli oris is also called the triangularis menti (triangular of the chin). The

depressor labii inferioris is also called quadratus menti (square of the chin). The levator labii inferioris is also called levator menti.

The opponens minimi digiti and opponens pollicis sometimes have in place of the word "opponens" the three words "flexor ossis metacarpi," making of the first, flexor ossis metacarpi minimi digiti.

Fig. 94.



MUSCLES OF THE HEAD, FACE, AND NECK.

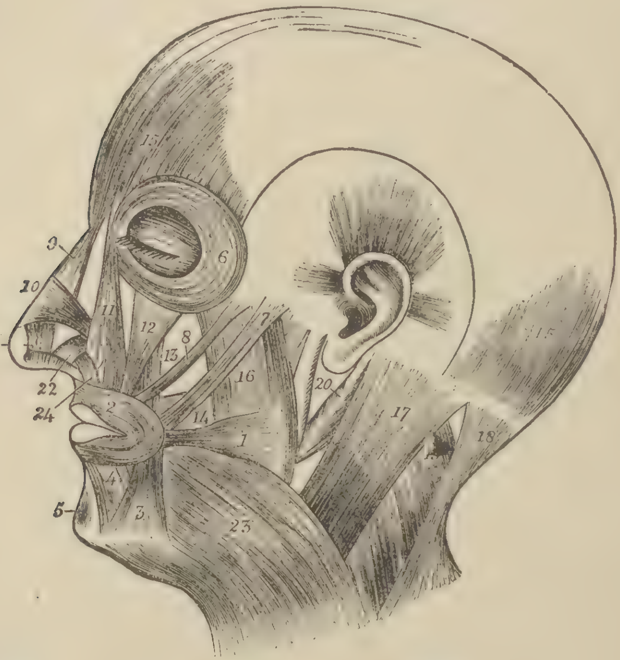
The palato-glossus is the constrictor isthmi faucium. The sterno-mastoid is the sterno-cleido-mastoid. The "triceps" is the triceps cubiti, or triceps extensor cubiti.

MUSCLES OF THE CRANIUM AND FACE (Twelve Groups).

The muscles of the cranium and face form twelve groups, named from the region which they occupy:—

FIRST.—Epicranial (upon the cranium), 1 muscle, the occipito-frontalis.

Fig. 95.



1. Risorius.
2. Orbicularis Oris.
3. Depressor Anguli Oris.
4. Depressor Labii Inferioris.
5. Levator Menti.
6. Orbicularis Palpebrarum.
7. Zygomaticus Major.
8. Zygomaticus Minor.
9. Pyramidalis Nasi,
10. Compressor Naris.
11. Levator Labii Superioris et Alæ Nasi.
12. Levator Labii Superioris.
13. Levator Anguli Oris.
14. Buccinator.
15. Occipito-frontalis.
16. Masseter.
17. Sterno-mastoid.
18. Trapezius.
19. Splenius Capitis.
20. Digastric.
21. Levator Proprius Alæ Nasi Anterior, or, Dilatator Naris Anterior.
22. Levator Proprius Alæ Nasi Posterior, or, Dilatator Naris Posterior.
23. Platysma Myoides.
24. Depressor Alæ Nasi.

SECOND.—Auricular (ear), 3 muscles. These are the attollens aurem (raising the ear), attrahens aurem (drawing the ear forward), and retrahens aurem (drawing the ear backward).

THIRD.— Tympanic (middle ear), 3 muscles: laxator tympani (loosener of the drum), tensor tympani (tightener of the drum), and stapedius (moves the stapes — "stirrup").

FOURTH. — Palpebral (eyelid), 3 muscles: orbicularis palpebrarum (round of the eyelids), corrugator supercilii (wrinkles the eyebrows), and tensor tarsi (compresses the tarsal cartilages).

FIFTH.— Intra-occular (within the eye), 1 muscle, the ciliary. This muscle adjusts the eye to different distances.

SIXTH.— Orbital (around the eyeball), 7 muscles: levator palpebræ (lifts the upper lid); rectus superior (turns the eye upward); rectus inferior (turns the eye downward); rectus internus (turns the eye inward); rectus externus (turns the eye outward); obliquus superior (rotates the eyeball); obliquus inferior (rotates the eyeball).

SEVENTH.— Nasal (nose), 7 muscles: compressor naris (compresses the nose); compressor narium minor (small compressor of the nostrils); depressor alæ nasi (constricts the nares); dilator naris anterior, dilator naris posterior (enlarge the aperture of the nose); levator labii superioris alæque nasi (lifter of the upper lip and wing of the nose); pyramidalis nasi (draws down the eyebrow).

EIGHTH.— Superior maxillary (upper jaw), 5 muscles: levator labii superioris (lifter of upper lip); levator anguli oris (lifter of the angle of the mouth); zygomatic major, zygomatic minor (raise the upper lip, and draw it outward, as in laughing); naso-labialis (connecting the upper lip and septum of the nose).

NINTH.— Inferior maxillary (lower jaw), 3 muscles: levator labii inferioris (lifter of the lower lip), depressor labii inferioris (depressor of lower lip), depressor anguli oris (depressor of angle of the mouth).

TENTH.— Intermaxillary (between the jaws), 5 muscles: buccinator (trumpeter — compresses the cheeks), risorius (laughing muscle — aids the zygomatic), orbicularis oris (closes the lips or mouth), accessorius orbicularis superioris (aids the orbicular), anomalus (irregular — between the nose and cheek).

ELEVENTH.— Temporo-maxillary (connecting the lower jaw and temporal bone), 2 muscles: masseter (masticator — raises the lower jaw), temporal (raises the lower jaw).

TWELFTH.— Pterygo-maxillary (connecting the pterygoid processes with the lower jaw), 2 muscles: pterygoid externus, pterygoid internus (raise the lower jaw and triturate the food).

MUSCLES OF THE NECK (Nine Groups).

FIRST.— Superficial muscles, 2 pairs: platysma myoid (broad, muscle-like), sterno-cleido-mastoid (named from its attachment to the sternum, clavicle, and mastoid process).

SECOND.— Infra-hyoid (below hyoid bone), 4 pairs: sterno-hyoid (connects the sternum and hyoid bone); sterno-thyroid (connects the sternum and thyroid cartilage); omo-hyoid (shoulder and hyoid bone); thyro-hyoid (thyroid cartilage and hyoid bone.)

THIRD.— Supra-hyoid (above the hyoid bone), 6 pairs. Digastric ("two bellies," the middle, fleshy part of a muscle is called its belly); genio-hyoid (chin and hyoid bone); genio-hyo-glossus (chin, hyoid bone, and tongue); hyo-glossus (hyoid bone and tongue); lingualis (forms the under part of the tongue); mylo-hyoid (lower jaw and hyoid bone).

FOURTH.— Submaxillary, 3 pairs: stylo-hyoid (styloid process and hyoid bone); stylo-glossus (styloid process and tongue); stylo-pharyngeus (styloid process and pharynx).

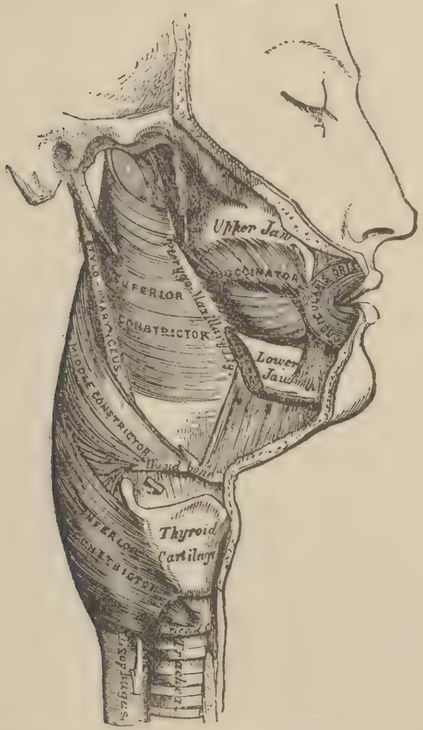
FIFTH.— Prevertebral (before the vertebræ), 7 pairs: longus colli (long of the neck); rectus capitis anticus major, rectus capitis anticus minor (these antagonize the post-vertebral muscles); rectus capitis lateralis (extends from the transverse process of the atlas to the jugular process of the occiput); scalenus anticus, scalenus medius, scalenus posticus (raise the first and second ribs, or flex the neck sideways. The scalene are all attached to the transverse processes of the cervical vertebræ, and extend to the first and second ribs).

SIXTH.— Post-vertebral (behind the vertebræ, 8 pairs: splenius capitis et colli (splenius of the head and neck), or, simply, splenius; trachelo-mastoid (lower cervical and upper dorsal vertebræ with the mastoid process); complexus (four of the lower cervical and upper dorsal vertebræ with the occipital bone); biventer cervicis (two-bellied of the neck,— blends with the complexus); obliquus capitis superior (superior oblique of the head); obliquus capitis inferior (inferior oblique of the head); rectus capitis posticus major, rectus capitis posticus minor (larger and smaller straight muscles of the head behind the spine).

SEVENTH.— Palatic (of the palate) 5 pairs: tensor palati (stretcher of the soft palate); levator palati (lifter of the palate); palato-glossus, or constrictor isthmi faucium (soft palate and side of the tongue); palato pharyngeus (soft palate with the throat and posterior border of the thyroid cartilage); azygos uvulæ (is *not* single, as its name implies. It extends from the palate bone to the uvula).

Eighth.—Pharyngeal (of the pharynx), 3 pairs: superior constrictor, middle constrictor, and inferior constrictor (these muscles are the chief agents of deglution, carrying the contents of the pharynx into the œsophagus).

Fig. 96.



MUSCLES OF THE PHARYNX—EXTERNAL VIEW.

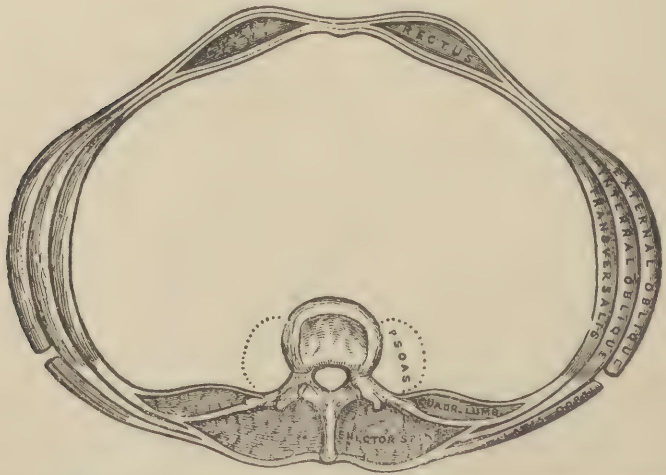
Ninth.—Laryngeal (of the larynx), 7 pairs and 1 single: arytenoid ("ladle-shaped," a single muscle, situated between the two arytenoid cartilages, and narrows the glottis); aryteno-epiglottideus superior (constricts the upper aperture of the larynx); aryteno-epiglottideus inferior (compresses the sack of the larynx); crico-thyroid (elongates and tightens the voca cords); crico-arytenoid posticus (rotates the arytenoid cartilages and opens the glottis); crico-arytenoid lateralis (rotates the cartilages and closes the glottis); thyro-arytenoid (shortens and relaxes the vocal cords); and thyro-epiglottideus (compresses the sack of the glottis).

MUSCLES OF THE TRUNK (Forty-six Pairs and Sets, in Four Groups).

FIRST.— Abdominal, 7 pairs in the male, 6 in the female: rectus abdominis (straight of the abdomen); pyramidalis (form of *one side* of a pyramid, triangular); obliquus externus (external oblique); obliquus internus (internal oblique); cremaster (found in the male only, and is really only some of the lower fibers of the internal oblique); transversalis abdominis (transverse of abdomen); and quadratus lumborum (square of the loins).

SECOND.— Thoracic (of the thorax — chest), 6 pairs, sets, or single: intercostal, external, 11 pairs; intercostal, internal, 11 pairs (between the ribs); infracostal (within the ribs — not constant); levatores costarum (lifters of the ribs), 12 pairs; triangularis sterni (triangular of the sternum, draws down the costal cartilages of the second, third, fourth, and fifth ribs); and the diaphragm (divider), separates the cavities of the chest and abdomen.

Fig. 97.



A TRANSVERSE SECTION OF THE ABDOMEN IN THE LUMBAR REGION.

THIRD.— Dorsal (of the back), 23 pairs and sets. These muscles are in five layers.

First layer.— Trapezius (named from its form: the two muscles taken together forming a quadrilateral, but one alone is triangular); and latissimus dorsi (broadest of the back).

Second layer.— Levator anguli scapulæ (lifter of the angle of the scapula); rhomboid major, and rhomboid minor (these two muscles, side by side, form one oblique-angled parallelogram [rhombus], and extend obliquely between the spine and posterior border of the scapula).

Third layer.— Serratus posticus superior and serratus posticus inferior ("saw-like," and placed at the upper and lower part of the back).

Fourth layer.—Cervicalis ascendens and transversalis colli (extend into the neck); accessorius ad sacro-lumbalem (aid to the sacro-lumbalis); spinalis colli (or spinalis cervicis) and spinalis dorsi (connect the spinous processes of the neck and back); longissimus dorsi (longest of the back); sacro-lumbalis (this and the preceding are parts of the erector spinæ); and erector spinæ (in the loins).

The erector spinæ extends from the sacrum to the lower rib, where it divides into the two preceding.

Fig. 98.

THE DIAPHRAGM.

Fifth layer.—Semi-spinalis dorsi; semi-spinalis colli; multifidus spinæ; rotatores spinæ, 11 pairs; supra spinales, 6 pairs; inter-spinales, usually 13 pairs; extensor coccygis; and intertransversales, 23 pairs. (These muscles all connect various parts of the vertebræ with each other, and may in general terms be called spinal muscles).

FOURTH.— Perineal (of the perineum), 7 pairs, 9 in both sexes. Erector penis (in the female, erector clitoridis instead); accelerator urinæ (absent in the female, but another is added — sphincter vaginæ); transversus perinei (transverse of the perineum); compressor urethræ (surrounds and compresses the membranous portion of the urethra); sphincter ani (external); levator ani, and coccygeus (in the floor of the pelvis).

The number of muscles in the perineum is increased to eight (ten if both sexes be considered), if we reckon the *internal sphincter ani*. It is an aggregation of the circular fibers of the rectum.

MUSCLES OF THE UPPER EXTREMITY (Forty-six Pairs and Sets, in Seven Groups.)

FIRST.— Brachio-thoracic muscles (connecting the arm and trunk), 4 pairs: pectoralis major, pectoralis minor (breast muscles — greater and less); subclavius (under the clavicle: connects the clavicle with the cartilage of the first rib); serratus magnus (great saw-tooth, or saw-like muscle: extends from the posterior border of the scapula to eight upper ribs at the side).

The serratus magnus rests upon the ribs and intercostal muscles, and is covered in front by the pectoral muscles, and behind by the subscapularis, which separates it from the scapula, or shoulder blade; so that we have two muscles lying between the shoulder blade and ribs.

SECOND.— Omo-brachial (connecting shoulder and arm), 7 pairs: deltoid (delta-like,— the delta *Δ*, is the fourth letter of the Greek alphabet, and is triangular in form); supraspinatus ("above the spine" of the scapula); infraspinatus ("below the spine" of the scapula); teres major, teres minor ("round, or smooth," greater and less); subscapularis (under the scapula); coraco-brachialis (coracoid process to the humerus).

THIRD.— Brachial (situated on the arm), 4 pairs: biceps flexor cubiti (two-headed flexor of the forearm); brachialis anticus (anterior brachial); triceps extensor cubiti (three-headed extensor of the forearm); subanconeus (connects the humerus and posterior ligament of the elbow. The last two are situated posteriorly upon the arm.

FOURTH.— Cubital (situated upon the forearm), 20 pairs,— of these the first eight are anterior; the last twelve, posterior: — flexor longus pollicis (long flexor of the thumb); flexor carpi ulnaris (ulnar flexor of wrist); flexor carpi radialis (radial flexor of the wrist); flexor profundus digitorum (deep flexor of the fingers); flexor sublimis digitorum (high flexor of the fingers); pronator radii teres (round pronator of the radius); pronator quadratus (square pronator); palmaris longus (long of the palm); extensor indicis (extensor of the index finger); extensor carpi ulnaris ("ulnar extensor of the wrist"); extensor minimi digiti (extensor of the little finger); extensor carpi radialis brevior (shorter radial extensor of the wrist); extensor carpi radialis longior (longer radial extensor of the wrist); extensor communis digitorum (common extensor of the fingers); extensor ossis metacarpi pollicis (extensor of the metacarpal bone of

the thumb); extensor primi internodii pollicis (extensor of the first plalangeal bone of the thumb); extensor secundi internodii pollicis (extensor of the second plalangeal bone of the thumb); supinator brevis (short supinator); supinator longus (long supinator); and anconeus ("elbow-muscle:" aids extension of the forearm).

FIFTH.— Thenal (forming the ball of the thumb), 4 pairs: abductor pollicis (abductor of the thumb); adductor pollicis (adductor of the thumb); flexor brevis pollicis (short flexor of the thumb); and opponens pollicis (or flexor of the thumb).

SIXTH.— Hypothenal (on the ulnar side of the palm), 4 pairs: abductor minimi digiti (abductor of little finger); flexor minimi digiti (flexor of little finger); opponens minimi digiti (opposition placer of the little finger); palmaris brevis (short muscle of the palm).

SEVENTH.— Palmar, 3 sets in each palm, containing 11 muscles. The three sets are the **lumbricales** ("earthworms," named from their appearance), 4 in number. (These muscles are aids, or parts, of the *deep flexor*. They arise from its tendons [in the foot they arise from the tendons of the *long* flexor], and are inserted into the aponeuroses of the *common extensor* of the fingers); **interossei palmares,** 3 in number (extend from the palmar surface of the metacarpal bones to the side of the bones of the first phalanx); and the **interossei dorsales,** 4 in number (extend from the sides of the metacarpal bones to the sides of the bones of the first phalanx).

MUSCLES OF THE LOWER EXTREMITY (Fifty-two Pairs and Sets in Twelve Groups).

FIRST.— Intra-abdominal (within the abdomen), 3 pairs: psoas magnus (great loin muscle); psoas parvus (not constant; it connects the vertebral column with the brim of the pelvis); and iliacus (iliac muscle; lies in the iliac fossa).

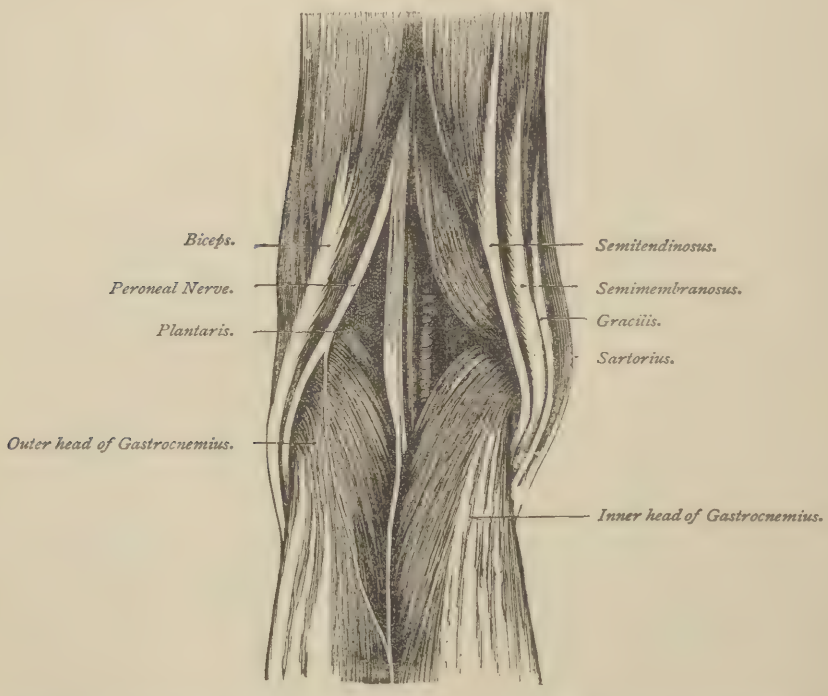
SECOND.— Anterior femoral, 7 muscles in each lower limb: tensor vaginæ femoris (tightener of the sheath of the thigh); sartorius (tailor's muscle, longest in the body); rectus femoris (straight of the thigh); vastus internus, vastus externus (named from their position and extent; they help to form the anterior portion of the thigh); crureus (inseparably connected with the vastus internus); and subcrureus (connects the synovial pouch of the knee with the shaft of the femur above the pouch).

THIRD.— Posterior femoral, 3 muscles, or 3 pairs in both limbs: biceps flexor cruris (two-headed flexor of the thigh); semitendinosus (has a very long tendon, and a tendinous intersection: connects

the ischium and tibia); and semimembranosus (has a membranous expansion: it connects the ischium and tibia).

FOURTH.—Internal femoral, 5 muscles: gracilis ("slender," extends from the pubis to the tibia); pectineus (extends from the pubis to the shaft of the femur, just below the smaller trochanter); adductor longus, adductor brevis, adductor magnus ("long," "short," and "great adductors" of the thigh. They are all attached to the linea aspera of the femur and to the pubis. The latter is also attached to the lower part of the ischium. The adductor magnus is inserted into the whole length of the linea aspera).

Fig. 99.



FIFTH.—Gluteal, or upper posterior, 9 muscles: gluteus maximus, gluteus medius, gleuteus minimus ("greatest," "middle," and "least breech" muscles: they abduct the thigh, and assist station and progression); gemellus superior, gemellus inferior ("upper" and "lower twins": they extend from the ischium to the great trochanter); obturator externus, obturator internus (extend from the pelvis to the great trochanter, and take their name from the obturator [closed up] foramen, whence they arise); pyriformis ("pear shape": is partly within the pelvis, and extends to the great trochanter); and quadratus femoris ("square of the thigh").

Fig. 100.

MUSCLES OF THE BACK OF THE LEG — DEEP LAYERS.

SIXTH.—Popliteal (in the popliteal space), 1 muscle—popliteus "ham muscle": it forms the floor of the popliteal space, from outer condyle to the shaft of the tibia).

SEVENTH.—Superficial posterior crural, 3 muscles: gastrocnemius ("belly, [or calf] of the leg": this, and the two following, form the tendo Achillis); soleus (shaped like the sole of a shoe: it lies within or beneath the gastrocnemius); and plantaris (extends from the femur to the os calcis: has a long, delicate tendon).

Fig. 101.

Fig. 102.

MUSCLES OF THE SOLE OF THE FOOT—FIRST LAYER.

Fig. 103.

MUSCLES OF THE FRONT OF THE LEG.

Eighth.—Deep posterior crural, 3 muscles: flexor longus pollicis (long flexor of great toe), flexor longus digitorum (long flexor of the toes), and tibialis posticus (posterior tibial

Fig. 104.

MUSCLES OF THE SOLE OF THE FOOT—SECOND LAYER.

Ninth.—Anterior crural, 3 muscles: extensor proprius pollicis (proper extensor of the great toe), extensor longus digitorum (long extensor of the toes), and tibialis anticus (anterior tibial).

TENTH.—Peroneal (in the region of the perone, or fibula), 3 muscles: peroneus brevis, peroneus tertius, and peroneus longus ("short," "third," and "long peroneal"); they extend from the fibula to the metatarsal bones, and extend the foot upon the leg; the latter everts the sole of the foot.

Fig. 105.

MUSCLES OF THE SOLE OF THE FOOT—THIRD LAYER.

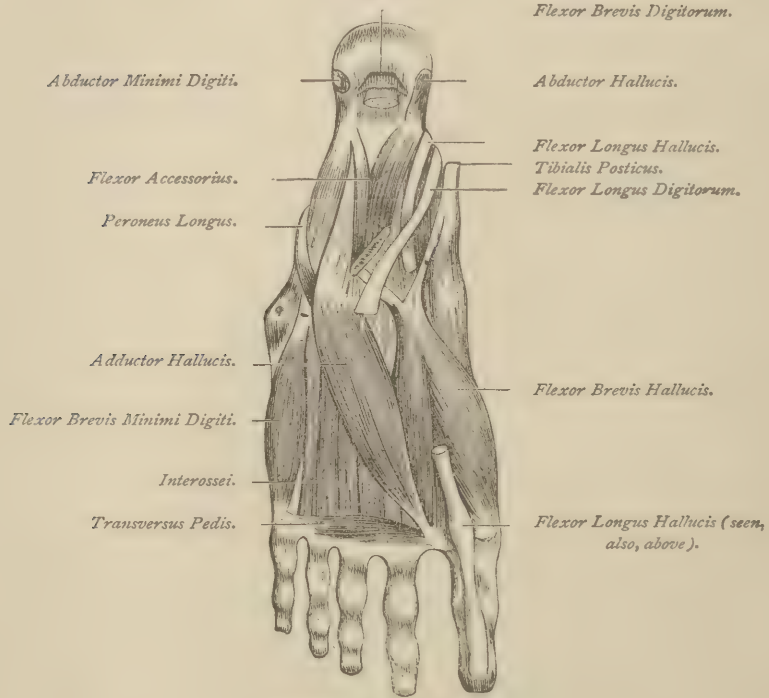
ELEVENTH.—Superior pedal (upper part, or dorsum, of the foot), 1 muscle: extensor brevis digitorum (short extensor of the toes).

TWELFTH.—Inferior pedal (under part, or sole of the foot), 11 muscles and sets. The last are in four layers, counted from the skin to the bones:—

First layer contains the abductor pollicis, flexor brevis digitorum, and abductor minimi digiti—3 muscles.

Second layer contains the flexor accessorius and the 4 lumbricales—1 pair and 1 set.

Fig. 106.



MUSCLES OF THE SOLE.

Third layer contains the flexor brevis pollicis, the abductor pollicis, flexor minimi digiti, and the transversus pedis (transverse of the foot)—4 muscles.

Fourth layer contains the dorsal and plantar interossei—2 sets, or 7 muscles.

There are four dorsal and three plantar interossei, counting from within outward, as we count the bones of each plalanx.

The dorsal interossei and lumbricales are found in both the upper and lower extremities, and consequently are counted twice *as sets;* but the aggregate of muscles is correctly given as 652 (324 pairs and 4 single).

There are 44 groups of muscles: 12 of the head, 9 in the neck, 4 in the trunk, 7 in the upper extremity, and 12 in the lower. The grouping facilitates study and aids the memory. The grouping already given has reference to the position, or *situation* of the muscles in the body.

The muscles may also be grouped with reference to their function, or office. We mention a few in illustration, and also describe them.

The muscles of *re*spiration include the muscles of *in*spiration and *ex*spiration. The ordinary muscles of inspiration are the diaphragm, three scalene, the levatores costarum, and the external intercostals. These may be assisted by the serratus posticus superior, the serratus magnus, and the pectoral muscles. The muscles of expiration are: the serratus posticus inferior, the infracostales, some of the abdominal, the sacro-lumbalis, triangularis sterni, and some portion of the internal intercostals.

The muscles of respiration are governed by the pneumogastric and spinal nerves.

The **diaphragm** ("divider," separating the cavities of the thorax [chest] and abdomen) is the most important muscle of inspiration, and is supplied by the sympathetic and two phrenic nerves. (The word "phrenic" [Greek φρην, the mind] relates to the diaphragm). The diaphragm (or midriff) is a flat muscle, somewhat circular or elliptical in form, attached at its circumference to the walls of the chest (six or seven lower ribs, costal and ensiform cartilages), and having a tendinous center, called the central tendon. In its passive condition it forms a dome, with its central tendon much higher than its circumference; but when it contracts, its central tendon is drawn downward into the plane of its circumference, and thus the cavity of the chest is enlarged for the reception of the pabulum of life — atmospheric air. The diaphragm is attached to the spine below by two crura (legs), which adhere to the second, third, and fourth lumbar vertebræ, and blend with the anterior common ligament of the spinal column.

Several important vessels pass through the diaphragm from the chest to the abdomen, or *vice versa*, from the abdomen to the chest. For this purpose there are three large openings and several smaller. The large openings are the aortic, the œsophageal, and the caval (for the inferior vena cava). The aortic opening is rather *behind* than *in* the diaphragm, since the aorta lies immediately in front of the bodies of the vertebræ at this joint, and passes down behind the diaphragm, and between the two crura (legs) which form its lower attachment.

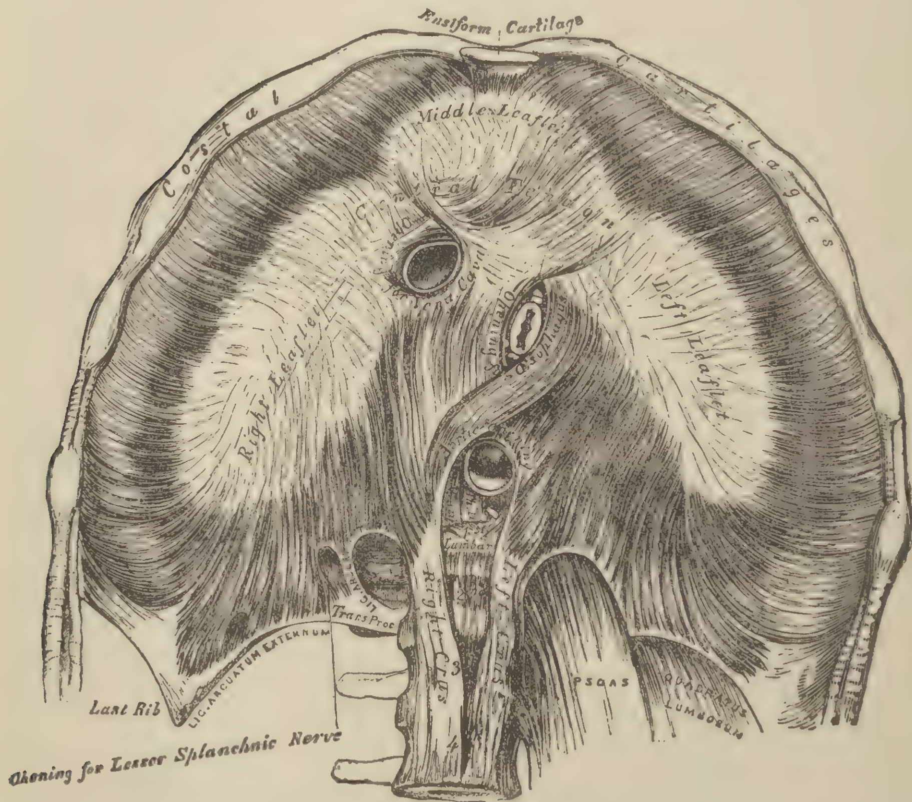
The aortic opening transmits the aorta, the thoracic duct, the vena azygos major, and occasionally the left sympathetic nerve.

The œsophageal opening is above, anterior, and a little to the left of the aortic. It transmits the œsophagus (signifying "to carry what we eat") and the pneumogastric (lung and stomach) nerves.

The "caval" opening is nearer the central part of the diaphragm, and a little to the right of the median line of the body.

The base of the pericardium (heart-case) is attached to the central tendon of the diaphragm, and is drawn downward at every inspiration.

Fig. 107.



UNDER SURFACE OF THE DIAPHRAGM.

Five tendinous arches are found in the posterior margin of the diaphragm; one in the median line, which forms the anterior part of the aortic opening, and two on either side, for the passage of the psoas magnus and quadratus lumborum muscles. The inner arch, nearer the spinal column, passes in front of the psoas magnus (great loin muscle—the surloin of beef) muscle, and receives the name of "ligamentum arcuatum internum" (internal arched ligament). The other arches

across the upper part of the quadratus lumborum (square of the loins) muscle, and is called the "ligamentum arcuatum externum" (external arched ligament).

The *crura* of the diaphragm are also called *pillars of the diaphragm.* They are really tendons of the diaphragm. The crura at their origin are tendinous, and blend with the anterior common ligament of the spine, as they lie upon the anterior surfaces of the bodies of the lumbar vertebræ. They become fleshy after forming the tendinous arch in front of the aorta, decussate (cross), and then diverge so as to surround the œsophagus (gullet) before ending in the central aponeurosis, called the central tendon of the diaphragm.

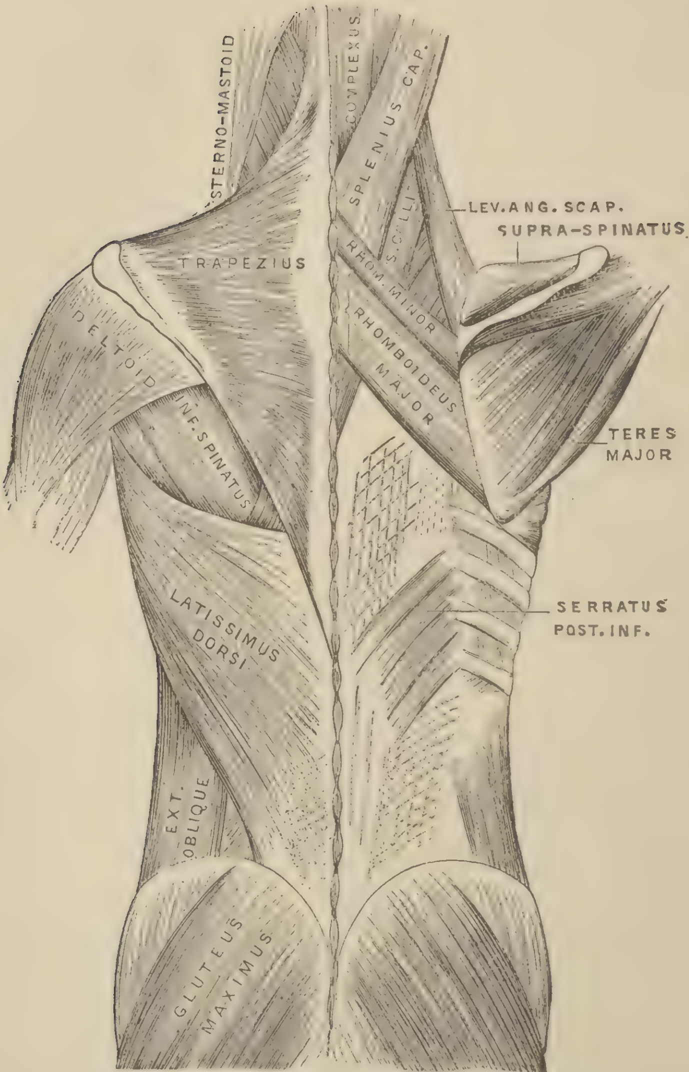
The under surface of the diaphragm is lined or covered by the peritoneum, which is the serous membrane that lines the abdominal cavity. The upper surface is in contact with three serous membranes — the two pluræ, that line the cavities filled by the lungs, and the pericardium (heart-case), which covers the middle portion of the central tendon.

The position of the diaphragm is constantly changing (except its points of attachment) during respiration; and in consequence the position of the organs above and below is constantly changing. The right portion of the diaphragm forms an arch over the convex upper surface of the liver, and supports the concave base of the right lung. The left portion supports the base of the left lung, and covers the great end of the stomach, the spleen, and left kidney.

During inspiration the diaphragm contracts, and pushes down the abdominal viscera; at the same time the heart is drawn downward, in connection with the action of the lungs. During expiration the diaphragm is passive, and the action of the abdominal muscles upon the viscera pushes it upward.

The **anterior** and **middle scalene muscles** extend from the first rib to the transverse processes of the vertebræ directly above. The posterior scalene extends from the second rib to the vertebræ (two or three lower cervical) above. The action of these muscles is to raise and fix the first and second ribs, or bend the spinal column to one side. They are governed by branches of cervical nerves. The lower part of the anterior scalene muscle generally separates the subclavian artery and vein. The artery lies behind the muscle with the brachial plexus of nerves. The **levatores costarum** (lifters of the ribs), twelve on each side, extend from the transverse processes of the vertebræ (the last cervical and first eleven dorsal) obliquely downward and outward to the rib below, near its angle. The first levator costæ vel costarum (lifter of the rib, or ribs) extends from

Fig. 108.



MUSCLES OF THE BACK—FIRST LAYER ON THE LEFT.

the transverse process of the last (seventh) cervical vertebra to the first rib; and the muscle for the twelfth rib arises from the eleventh dorsal vertebra. These muscles are supplied by the dorsal nerves.

The **external intercostals**, eleven in number on each side, are attached to the adjacent margins of the ribs above and below, and when they contract, cause the ribs to approximate. Their fibers are directed obliquely downward and forward, like those of the external

oblique muscle of the abdomen. They are supplied by the intercostal nerves (anterior dorsal, or spinal nerves).

The **serratus posticus superior** is named from its position and form (serra,—a saw). It lies upon the back, between the shoulders, in the third layer, and extends from the ligamentum nuchæ and spinous processes of three or four vertebræ, downward and outward, to the ribs (second, third, fourth, and fifth), a little beyond their angles. It antagonizes the **serratus posticus inferior.** The latter is situated also in the third layer of the muscles of the back, but opposite the junction of the dorsal and lumbar regions. It extends from the spinous processes of the vertebræ (two dorsal and two or three lumbar), upward and outward, to the lower borders of the four lower ribs, a little beyond their angles. The upper serratus is supplied by branches of the cervical nerves; the lower serratus, by branches of the dorsal.

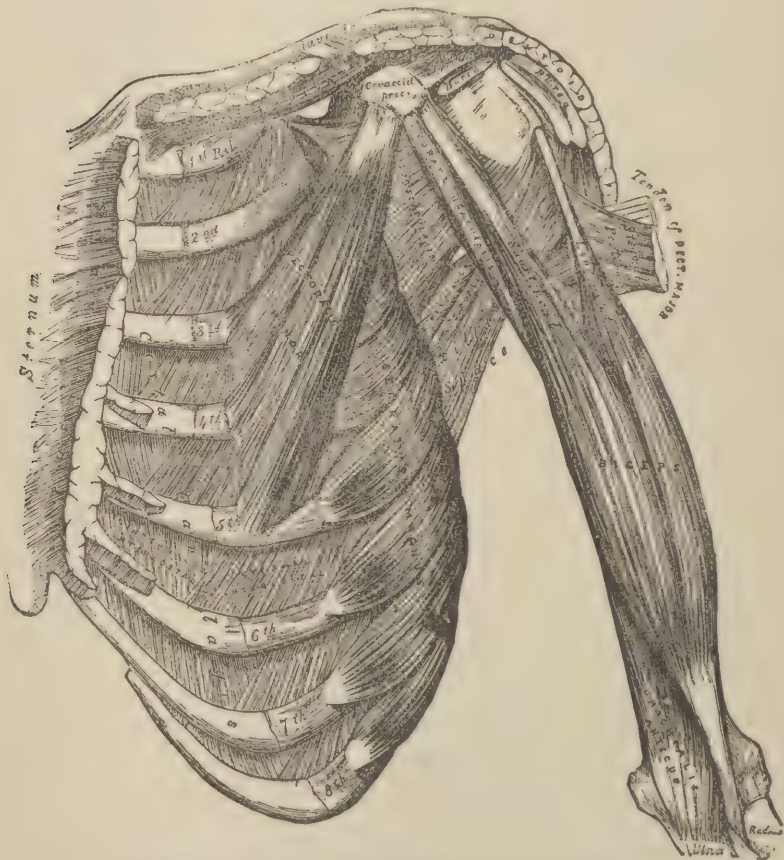
The **serratus magnus** (great saw-like) muscle is situated at the side of the chest, and is the most important external inspiratory muscle. It extends from the side of the chest beneath the pectoral muscles and shoulder blade, to the vertebral border of the scapula (shoulder blade). Its deep surface rests upon the ribs and intercostal muscles. It arises at the side, by nine fleshy digitations, from the upper border of the eight upper ribs (the second rib having two points of attachment). It is a broad, thin muscle. The direction of its fibers is generally upward and backward, but those of its middle portion are nearly horizontal. The lower portion (four lower digitations) interdigitates with processes of the external oblique muscle (one of the abdominal). The subscapular muscle lies between this muscle (serratus magnus) and the scapula, giving us two muscles between the shoulder blade and ribs. It is supplied by the posterior thoracic nerve (long thoracic, external respiratory of Bell). This nerve has two or three roots from the lower cervical nerves.

The pectoral muscles are the **pectoralis major** and **pectoralis minor.** (See list of illustrations for muscles of the chest, etc. They take their name from size and position (pectus,—breast; major and minor,—greater and less). The greater is the more superficial, and covers the entire breast from the sternum and clavicle to the shoulder, being inserted into the bicipital groove of the humerus. The smaller is beneath, and extends from three of the ribs (third, fourth, and fifth) to the coracoid (raven-like) process of the scapula.

These muscles are supplied by branches of the brachial plexus of nerves. (The brachial plexus is formed by the intermixture of the anterior branches of the four lower cervical and first dorsal nerves.) The infra-costales (within the ribs) are not constant. When found,

they descend obliquely from one rib (costa) to another. The abdominal muscles (excepting the cremaster) assist expiration, by compressing the contents of the abdomen against the diaphragm. They also flex the vertebral column. They are chiefly named from the direction of their fibers,—**straight** (rectus), **transverse** (transversalis), **external** and **internal oblique.** The pyramidal and quadratus lumborum are named from their shape, and the cremaster (suspender) from its function of suspending the testicle.

Fig. 109.



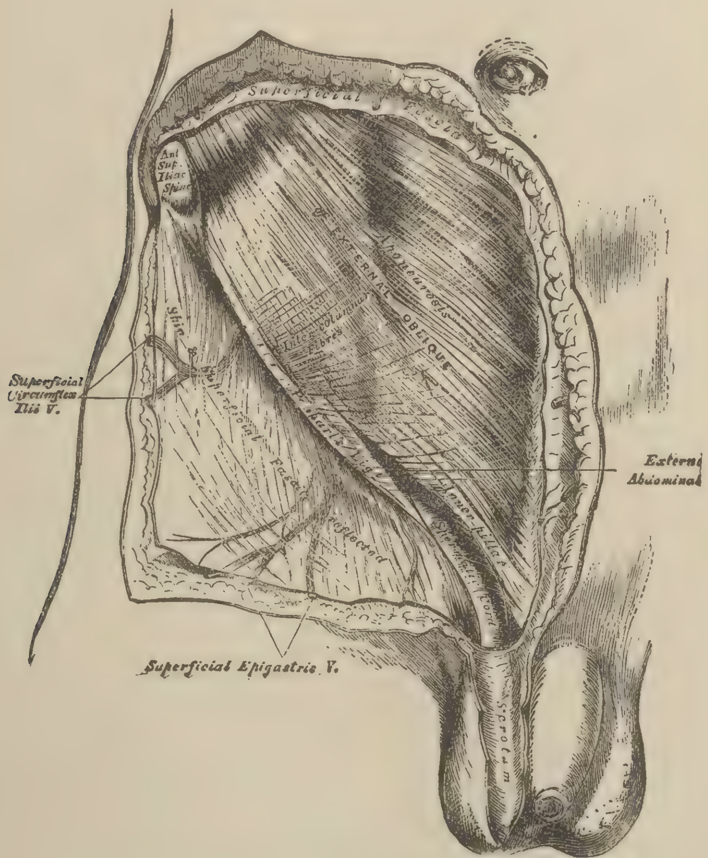
MUSCLES OF THE CHEST, AND BICEPS OF THE ARM.

The **straight (recti) muscles** of the abdomen — one on each side of the median line of the body — extend from the pubes directly upward to the ensiform and costal cartilages of the chest. They are partly tendinous, so as to seem composed of three or four shorter muscles. Each rectus is inclosed in a sheath, formed by the apo-

neuroses of the oblique and transverse muscles of the abdomen along the upper *three fourths* of its course, but the posterior wall of the sheath terminates at the commencement of the *lower fourth* of the muscle, leaving it separated from the peritoneum only by the transversalis fascia.

The **external oblique** is the most superficial of the three flat muscles covering the anterior of the abdomen; the internal oblique

Fig. 110.

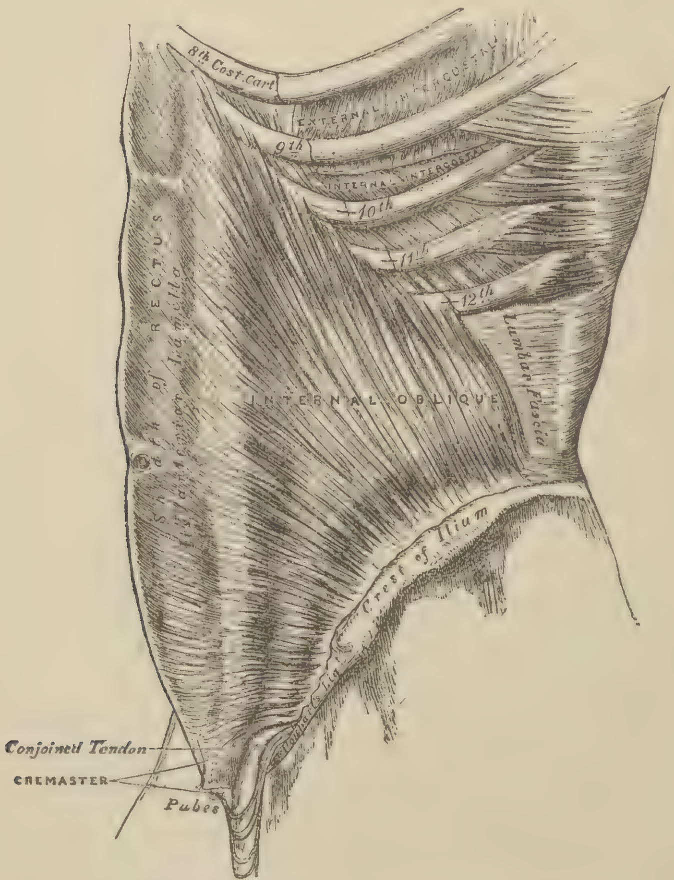


EXTERNAL OBLIQUE MUSCLE, AND SPERMATIC CORD.

lies next; and the transverse is the most internal, and nearest to the peritoneum, which covers the bowels,—or we may remember that the internal oblique forms the middle layer. The sheath of the rectus, along the upper three fourths of its length, is really formed by the aponeurotic plates of the internal oblique muscle but blends with the aponeuroses of the transverse behind and the external oblique in front

The fibers of the external oblique run downward and inward, nearly parallel with Poupart's ligament; the fibers of the internal oblique run upward and inward, crossing the former nearly at right angles; the transverse run nearly horizontal, and the recti (if we speak of the two), vertically. The external oblique is fleshy at the side and aponeurotic in front. Its aponeuroses form the linea alba ("white line," concealed by the integument), Poupart's and Gimbernat's ligaments,

Fig. 111.



THE INTERNAL OBLIQUE AND CREMASTER MUSCLES.

and the external abdominal ring. It is an important muscle, on account of its connection with inguinal hernia (rupture in the groin). It is a large muscle, extending from the pectoralis major above to the crest of the ilium and pubes below. It interdigitates at the side of the body with two muscles (the serratus magnus and latissimus dorsi),

where it is attached to the ribs, and is irregularly quadrilateral in form. The **internal oblique** extends from the outer half of Poupart's ligament and the crest of the ilium to the linea alba and cartilages of the four lower ribs (ninth, tenth, eleventh, and twelfth). Its lower border forms the upper boundary of the inguinal (in the male sometimes called the spermatic) canal. At the crest of the pubes (or pubis, spelled both ways in the lexicons) this muscle (internal oblique) unites with the transverse (transversalis), to form what is called "the conjoined tendon of the internal oblique and transversalis." This tendon constitutes a strong aponeurosis behind the external abdominal ring (external opening of the inguinal canal beneath the integument).

The **transverse muscle** of the abdomen extends from the outer part of Poupart's ligament, the crest of the ilium, lumbar fascia, and cartilages of the six lower ribs, to the crest of the pubes and linea alba. The lower and internal portion of the muscle lies beneath and behind the inguinal canal.

The abdominal muscles are supplied by branches of the dorsal and lumbar nerves (spinal nerves).

The **lumbar fascia** (loin bandage) is only another name for the broad aponeurosis (expanded tendon) of the transverse muscle, blended with other aponeuroses. It divides into three layers, and contains between its anterior and middle layers the square muscle of the loins (quadratus lumborum), and between its middle and posterior layers the erector spinæ.

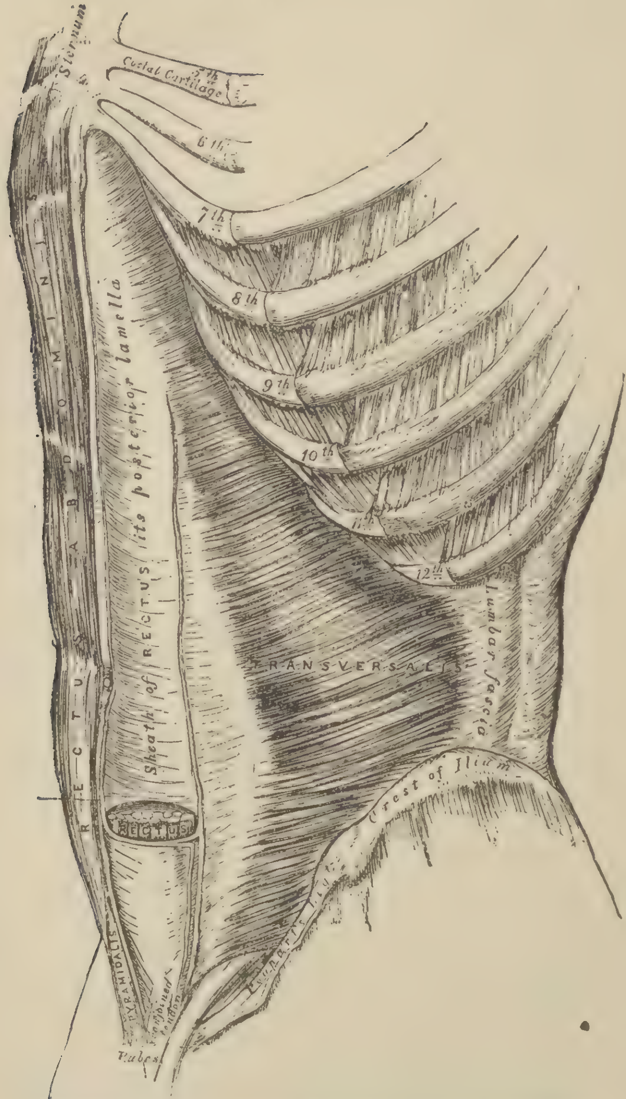
The **quadratus lumborum** extends along the side of the spine between the crest of the ilium and lower rib

The sacro-lumbalis muscle is a part of the erector spinæ. It lies upon the back, and extends from the sacrum and back part of the crest of the ilium upward to the angles of the six lower ribs.

The **triangularis sterni** (triangular of the sternum [breast-bone]) is situated upon the inner wall of the front of the chest, and lies between the sternum and the pleura. It arises from the lower part of the sternum, from the inner surface of the ensiform cartilage, and from the costal cartilages of the *lower* true ribs (three or four of them), and is inserted by fleshy digitations into the lower border of the costal (rib) cartilages of the ribs above (the second, third, fourth, and fifth). It serves to draw these costal (rib) cartilages together, and thus compress the chest.

The **internal intercostals** (muscles between the ribs) lie on the inner surface of the external intercostals, and extend, in each case, from the border of the rib below to the border of the rib above. Their fibers run, obliquely upward and forward, across the fibers of the

Fig. 112.



TRANSVERSE AND RECTUS MUSCLES OF THE ABDOMEN.

external intercostals, which run upward and backward. This crossing of fibers contributes to the strength of the chest walls.

The **pyramidalis** lies in front of the *lower part* of the rectus. It is triangular in form, as its name implies, with its base resting on the pubes, and its apex terminating in the linea alba half way to the umbilicus. When the pyramidalis is wanting, the lower end of the rectus muscle is larger.

The **cremaster** has its origin and insertion in the lower fibers of the internal oblique, or, more properly, is identical with them. The lumbar fascia and cremaster muscles are not included among the muscles of expiration.

The **muscles of deglutition** (swallowing) are the muscles of the tongue, the elevators of the hyoid bone, the three constrictors of the pharynx (throat), the stylo-pharyngeus, palato-glossus, palato-pharyngeus, tensor palati, and the muscular fibers of the œsophagus (gullet).

Deglutition is divided into three periods. During the first period the contents of the mouth are carried into the pharynx; during the second, into the œsophagus; and during the third into the stomach. The first period is controlled by voluntary muscles.

The muscles of deglutition are controlled by the cervical portion of the sympathetic and branches from five pairs of cranial nerves (trifacial, facial, hypoglossal, glosso-pharyngeal, and pneumogastric). The muscles of the tongue are described with that organ. The elevators of the hyoid bone are the digastric (two bellies), stylo-hyoid, mylo-hyoid, and genio-hyoid.

The **digastric** is a small muscle below the side of the lower jaw, extending indirectly from the mastoid process of the temporal bone behind the pinna, or auricle (the external ear) to the lower border of the jaw, close to the median line. Its two bellies are the anterior and posterior, and they are separated by the central tendon, which passes through a loop in the tendon of the stylo-hyoid muscle near the hyoid bone. The anterior belly is supplied from the motor root of the fifth cranial nerve, and the posterior belly from a branch of the seventh cranial (facial).

The **stylo-hyoid** (styloid process and hyoid bone) is a small, slender muscle in front of the posterior belly of the digastric. The name indicates its attachments — supplied by the facial nerve.

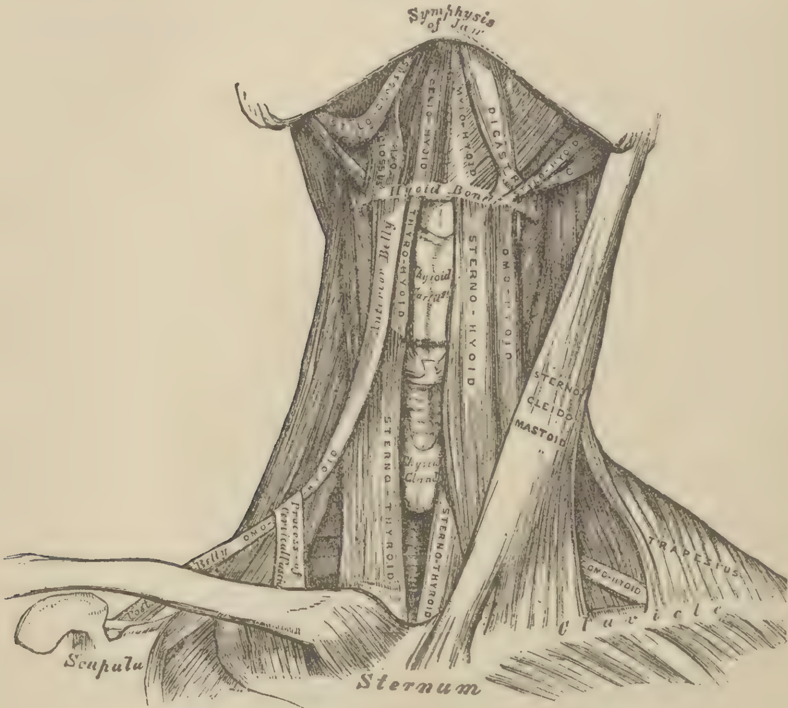
The **mylo-hyoid** is a flat, triangular muscle attached to the lower jaw and hyoid bone, as is indicated by the name. It forms with its fellow a muscular floor for the cavity of the mouth — supplied by a branch of the fifth cranial nerve, or (what amounts to the same) by the mylo-hyoid branch of the inferior dental nerve (branch of the fifth).

The **genio-hyoid** (chin and hyoid bone) extends from the inner side of the symphysis menti (union of the chin) directly downward and backward to the hyoid-bone. Supplied by the hypoglossal (cranial) nerve.

The three **constrictors of the pharynx** are placed one below another, and are named, from their position, the superior, middle, and inferior. The lower overlaps the middle constrictor, and the middle overlaps the upper, the lower being most superficial, and also the

thickest. These three muscles may in some respects be described together. They all lie without (or are lined by) two membranes — the mucous membrane of the pharynx (throat), and a fibrous membrane called the "pharyngeal aponeurosis"; they are all connected, posteriorly, to a fibrous raphé (seam) in the median line; and they are all incomplete, anteriorly, and bring to their aid the tongue and larynx,

Fig. 113.



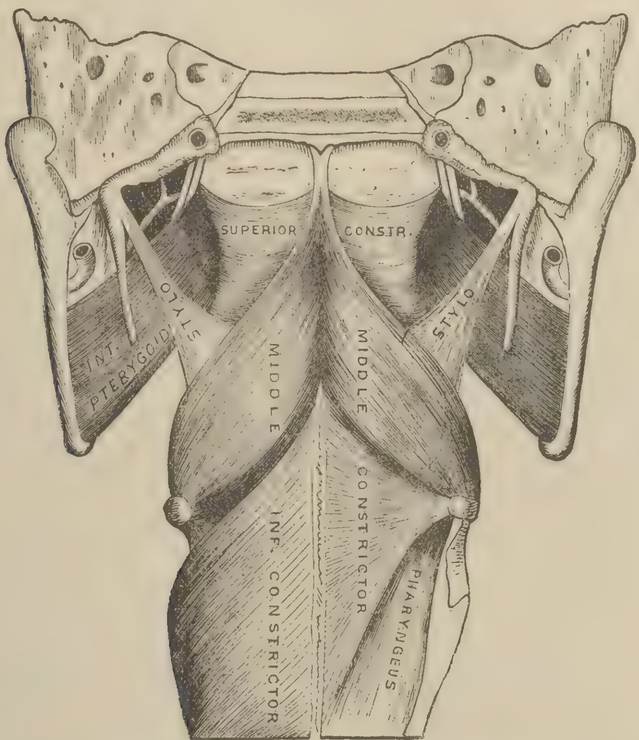
MUSCLES OF THE NECK — ANTERIOR VIEW.

which lie in front. The inferior constrictor is attached, in front, to the cricoid and thyroid cartilages (parts of the larynx); the middle constrictor to the hyoid bone and stylo-hyoid ligament; and the superior constrictor to the internal pterygoid plate, the pterygo-maxillary (pterygoid process and lower jaw) ligament, lower jaw, and tongue. From these points of attachment, in front, the fibers of these muscles curve backward to the median raphé, and the superior constrictor is, in addition, prolonged by means of an aponeurosis to the pharyngeal spine on the basilar process of the occipital bone. The three muscles are all in relation, posteriorly, with the vertebral column, and are supplied by branches from the sympathetic and pneumogastric nerves.

The **stylo-pharyngeus** is a long, slender muscle, and extends, as its name implies, from the styloid process, downward and inward, along the side of the pharynx, to the lower constrictor muscles and thyroid cartilage; supplied by the glosso-pharyngeal nerve.

The **palato-glossus** will be described with the tongue, but, as it assists in swallowing, should be mentioned here. It is called sometimes the constrictor isthmi faucium (constrictor of the isthmus of the

Fig. 114.



THE CONSTRICTOR MUSCLES — SEEN FROM BEHIND.

fauces), because it narrows the passage between the mouth and throat (pharynx). Covered with the mucous membrane of the mouth and throat, it forms the anterior pillar of the soft palate, and extends from the soft palate (velum palati, or veil of the palate) on either side of the uvula (or uvule), to the side of the tongue at its back part, in front of the tonsil. It causes the soft palate and side of the tongue to approximate. It is supplied from Meckel's ganglion (a part of the sympathetic system).

The **palato-pharyngeus** (palate and throat), with its mucous covering, forms the posterior pillar of the soft palate. It is separated from the palato-glossus (palate and tongue) by a triangular interval, that forms the lateral (side) boundary of the isthmus faucium (isthmus of the fauces, or simply the fauces). It is at the base of this interval that the tonsil lies — one on either side. The muscle extends from the soft palate to the side of the pharynx and thyroid cartilage. It is supplied from Meckel's ganglion.

During the first period of deglutition (swallowing), the food is carried into the fauces by the pressure of the tongue against the hard palate (roof of the mouth), the larynx being at the same time raised with the pharynx, and carried forward under it. During the second period the food is carried by the constrictor muscles into the œsophagus (gullet); and during the third into the stomach, by the muscular fibers of the œsophagus, which are continuous with the fibers of the inferior constrictor of the pharynx.

The food is prevented from entering the posterior nares (nostrils) by the elevation and tense condition (by action of the tensor palati) of the soft palate, and from entering the mouth by approximation of the palato-pharyngeus (palate and throat) muscles and uvula. The latter (the uvula) fills up the slight interval between the two muscles.

The **muscles of mastication** are the temporal, masseter, buccinator, internal, and external pterygoid. (See list of illustrations.) They are all supplied by the inferior maxillary nerve — a branch of the fifth pair of cranial nerves. The buccinator has also, some branches from the facial, which is a part of the seventh pair.

The **temporal muscle** lies in the temporal fossa, passes beneath the zygomatic arch, and is inserted into the coronoid (crow-like) process of the lower jaw. The coronoid process is straight, like the crow's beak, while the coracoid is curved like the beak of a raven.

The **masseter** extends from the zygomatic arch and malar process of the upper jaw to the ramus and angle of the lower jaw.

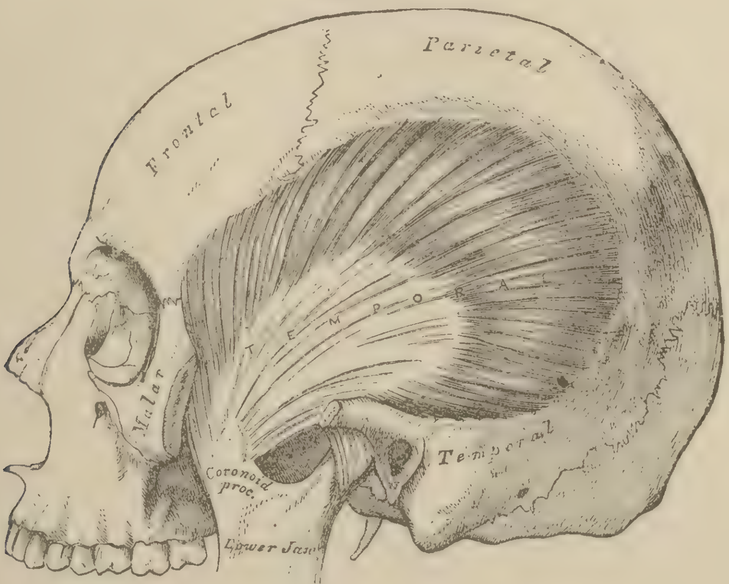
The **buccinator** (trumpeter, used in blowing wind instruments) occupies the interval between the jaws at the side of the face. It is attached to the outer surface of the alveolar processes of the upper and lower jaws, opposite the molar teeth, and to the anterior border of the ligament (pterygo-maxillary), which connects the pterygoid process with the internal surface of the lower jaw, and extends forward to blend with the fibers of the muscles near the angle of the mouth. It lies next to the mucous membrane of the mouth, and is covered in part by the masseter and other muscles.

The **internal pterygoid** (see figures of pterygoid muscles) resem-

bles the masseter in form and in the direction of its fibers. It extends from the pterygoid fossa of the sphenoid bone downward, outward, and backward, to the inner surface of the ramus and angle of the lower jaw. It lies close to the superior constrictor of the pharynx.

The **external pterygoid** muscle consists of two portions. One portion is attached to the posterior surface of the upper jaw and palate bones, and the other, higher up, to the great wing of the sphenoid.

Fig. 115.



THE TEMPORAL MUSCLE, LYING IN THE TEMPORAL FOSSA.

Both portions are inserted into the neck of the condyle of the lower jaw, and the fibro-cartilage of the joint (temporo-maxillary). These two portions together form a muscle somewhat conical in form, and extending almost horizontally between the zygomatic fossa and condyle of the jaw. It draws the lower jaw directly forward, one side at a time, or both sides together.

The eight **muscles of the larynx** (ninth group of the neck) form the muscles of phonation (use of the voice), and will be described with the larynx. They are supplied by branches of the sympathetic and pneumogastric nerves; or, more particularly, by the superior and inferior (also called "recurrent") laryngeal nerves.

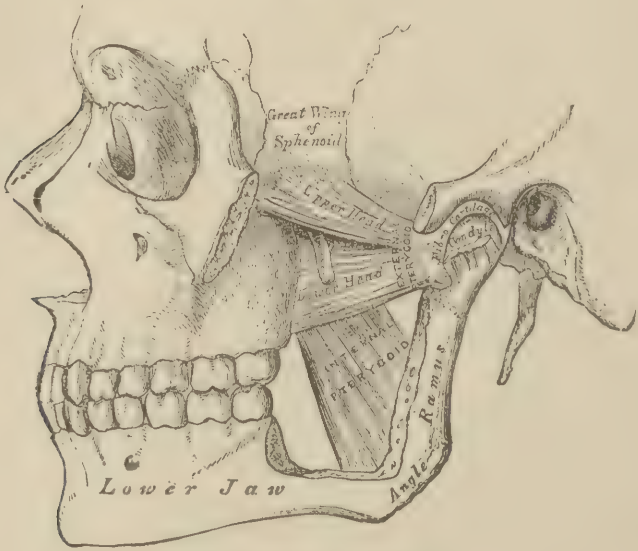
The **muscles of expression** include seven groups of the cranium and face (the first, fourth, sixth, seventh, eighth, ninth, and tenth),

containing 61 muscles — 30 pairs and 1 single. These are nearly all controlled by the facial (seventh cranial) nerve.

The biceps muscles are *flexors*, both in the leg and arm; the triceps muscles are *extensors* in both the leg and arm. The biceps of the arm is anterior; that of the leg posterior. This is because the leg is flexed backward and the arm forward. The triceps of the thigh is anterior, and the triceps of the arm posterior, for the same reason.

The tendon of the biceps femoris forms the **outer hamstring**; the **inner hamstring** is formed by four muscles (gracilis, sartorius, semi-

Fig. 116.

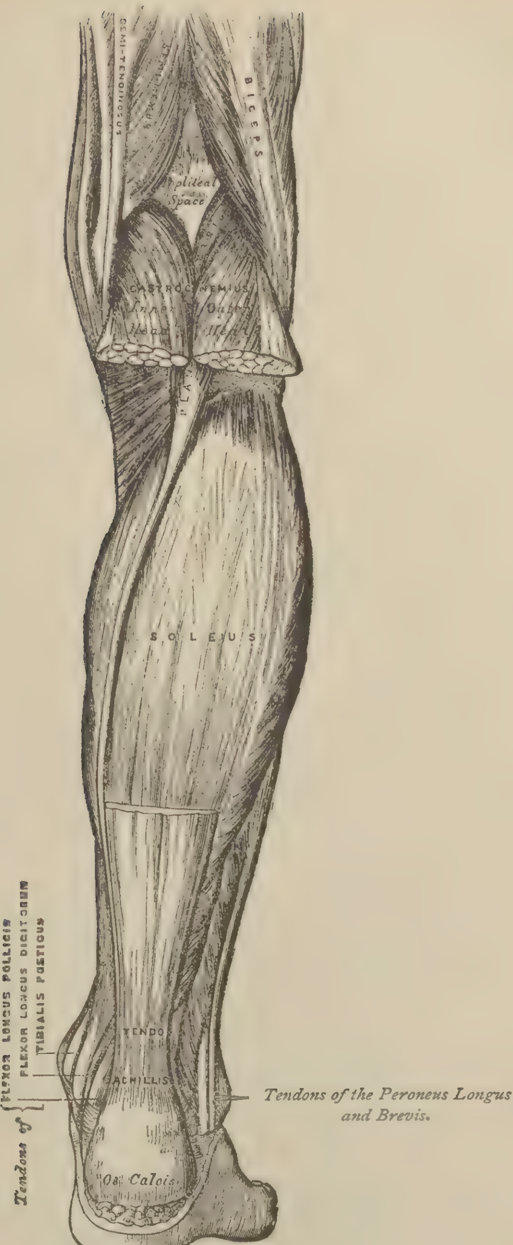


THE PTERYGOID MUSCLES.

membranosus, and semitendinosus). These hamstrings can be easily felt under the knee when the leg is flexed at a right angle as in sitting, and the muscles are slightly contracted.

The **gastrocnemius** and **soleus** together form the calf of the leg, and since the gastrocnemius has two heads, these muscles are sometimes called the triceps suræ (three-headed of the calf of the leg), or extensor pedis (extensor of the foot). They are inserted into the os calcis by means of the tendo Achillis, and extend the foot; or, when the person is standing, raise him upon the toes. The two heads of the gastrocnemius arise from the upper and back part of the condyles of the femur. The soleus arises from the head and upper part of the fibula and shaft of the tibia.

Fig. 117.



MUSCLES OF THE BACK OF THE LEG — SUPERFICIAL LAYER.

The leg is flexed upon the thigh by the muscles that form the hamstrings already mentioned. The popliteus also aids the hamstring muscles to flex the leg.

The leg is extended by the **quadriceps extensor**, which is made up of four muscles (rectus, crureus, vastus externus, and vastus internus), and is attached to the patella.

The forearm is flexed chiefly by the biceps and anterior brachial (brachialis anticus), and extended by the triceps and anconeus.

We shall briefly describe some of the larger and more important muscles, and refer the reader to other works for a more definite description of the rest.

Fig. 118.

OCCIPITO-FRONTALIS, AND EXTERNAL MUSCLES OF THE EAR.

A. Attollens Aurem. C. Retrahens Aurem.
B. Attrahens Aurem. D. Part of the Orbicularis Palpebrarum.

The **occipito frontalis** covers the head from the occiput to the eyebrows. Its middle part, which covers the vertex (crown of the head), is aponeurotic; its extremities fleshy. Some anatomists regard this as a single muscle. Its frontal portion is connected or joined with the muscle of the opposite side; but its occipital portion is *separated* from its fellow by a variable interval. It raises the eyebrows, corrugates the forehead transversely, and moves the scalp: controlled chiefly by the facial nerve.

The **platysma myoid** (broad, muscle-like) is superficial, lying next to the skin. (See "muscles of the head, face, and neck," in list of illustrations.) It covers the side of the neck, extending from the clavicle

and areolar tissue (or fascia) that covers the pectoral muscles to the chin and lower jaw. Its fibers are parallel with each other, and pass obliquely upward and inward. It draws down the lower lip and angle of the mouth as in the expression of melancholy—governed by the facial nerve.

The **sterno-cleido-mastoid** (sternum-clavicle and mastoid process; its name indicating its origin [from the sternum and inner end of the clavicle] and insertion [into the mastoid process]) passes obliquely across the side of the neck. There is usually a triangular interval

Fig. 119.

MUSCLES OF THE NECK AND BOUNDARIES OF THE SURGICAL TRIANGLES.

between its sternal and clavicular origins; but the clavicular origin may be wanting, or may be very wide. The muscle is rendered very prominent when the head is turned toward the opposite side. It rotates the head to one side when one muscle acts singly; acting together, the two bend the head directly forward. This muscle is in close relation with important blood-vessels and nerves (common carotid artery, jugular veins, pneumogastric and spinal accessory

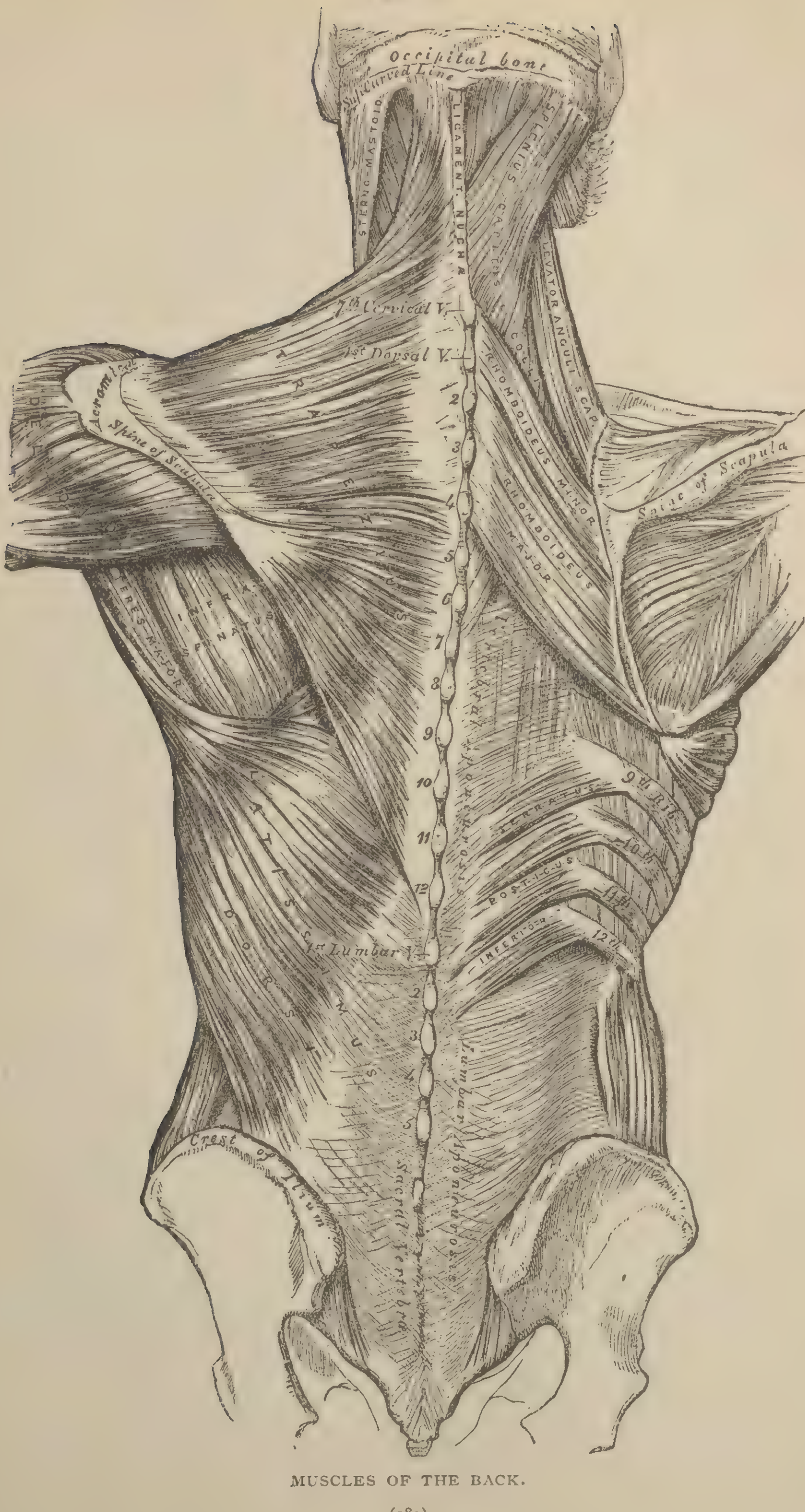
nerves), and serves to mark the division between the anterior and posterior triangles of the neck. The external jugular vein lies between this muscle and the platysma myoid; the internal jugular, the carotid artery, and pneumogastric nerve *beneath* this muscle. It is governed by the spinal accessory nerve (one of the cranial nerves).

The **trapezius** (see muscles of the back) is a large, flat, superficial muscle in the form of a triangle. The base of the triangle extends from the head (the occipital bone) along the spine to the loins (or to the last dorsal vertebra). The vertex of the triangle is at the shoulder (the acromion process of the scapula). The fibers of the muscle arising from the spinal column converge toward the shoulder, where they adhere to the spine of the scapula, acromion process, and outer end of the clavicle. The two muscles (one on each side of the spine, or spinal column) taken *together* form a trapezium, or diamond-shaped quadrangle; two opposite angles corresponding to the shoulders, and the other two to the occipital protuberance and last dorsal vertebra. The anterior margin of this muscle in the neck extends from the clavicle below to the occipital bone above, and forms the posterior boundary of the posterior triangle of the neck. The trapezius moves the shoulder, elevating, depressing, or carrying it backward, by the separate action of its various parts. It also draws the head backward and to one side. It is controlled by branches of the spinal accessory nerve.

The **latissimus dorsi** is also a large, flat, and, for the most part, superficial muscle. It covers the region of the loins (lumbar region). The lower part of the trapezius overlaps its upper dorsal portion. It extends from the lower half of the spinal column (six lower dorsal, and all the lumbar vertebræ and sacrum) to the bicipital groove of the humerus. It is also attached to the back part of the crest of the ilium, and to three or four lower ribs. The latissimus dorsi draws the arm backward and downward; or when the arm is fixed, as in climbing, it draws up the trunk. By fixing the arms, asthmatic patients cause it to act as a muscle of inspiration, by drawing up the lower ribs. It is governed by the long subscapular nerve from the brachial plexus (a network of branches from the four lower cervical and first dorsal of the spinal nerves).

The **deltoid** (delta-like) covers the shoulder joint. It is attached to the outer third of the clavicle, and to the acromion process and spine of the scapula; and since these parts are movable, and are also attached to the trapezius muscle, whose fibers run in nearly the same direction, the deltoid may in some sense be considered as an extension of the trapezius, although the two are entirely distinct. The deltoid

Fig. 120.



MUSCLES OF THE BACK.

is inserted into the outer surface of the humerus, a little above its middle, by means of a strong tendon. It moves the arm as the trapezius moves the shoulder, directly upward from the side, so as to bring it at right angles with the trunk, and by aid of other muscles forward or backward. It is supplied with stimulus from the circumflex nerve from the brachial plexus.

Fig. 121.

THE TRICEPS AND MUSCLES ON THE BACK OF THE SCAPULA.

The **supraspinatus** (occupying the supraspinous fossa of the scapula), the **infraspinatus** (occupying the infraspinous fossa, *i. e.*, below the spine of the scapula), and the **teres minor** (from the axillary border of the scapula), are inserted respectively into the highest, middle, and lowest facets upon the greater tuberosity of the humerus, or, we may say, at the upper part of the anatomical neck of the humerus. The teres minor is supplied by the circumflex, and the other two by the suprascapular nerve. The supraspinatus raises the arm. The infraspinatus and teres minor rotate the humerus outward. These

Fig. 122.

MUSCLES OF THE CHEST AND FRONT OF THE ARM.

muscles also afford great protection to the shoulder joint from dislocation.

The **teres major** ("greater round" muscle [see muscles on the dorsum of the scapula"]) extends from the scapula (near the inferior angle) to the bicipital groove of the humerus. It rotates the arm

inward and carries it backward; supplied by the lower subscapular nerve. The two tendons of this muscle and the latissimus dorsi are separated at their insertion into the humerus by a synovial bursa.

The **subscapularis** (under the scapula) lies beneath the scapula, and extends from the subscapular fossa to the smaller tuberosity of the humerus. It acts with the teres major to rotate the arm inward. It is governed by the subscapular nerves from the brachial plexus.

The **biceps flexor cubiti**, or, simply "biceps," of the arm, is the main flexor of the forearm. It is situated at the anterior and internal part of the arm, and extends from the upper edge of the glenoid cavity and from the coracoid process to the radius, just below the elbow (to the tubercle, or tuberosity of the radius). It extends along the humerus, but is not attached to it. It is controlled by the musculo-cutaneous nerve, which is a branch of the brachial plexus. The latter is formed by branches of the spinal nerves (four cervical and one dorsal).

The **triceps extensor cubiti**, or triceps of the arm, is situated on the back of the arm, and extends the entire length of the humerus. It is divided above into three parts, as its name (triceps, three-headed) implies. The long head arises from the inferior margin of the glenoid cavity and capsular ligament, and the other two heads (the "outer" and "inner") from the shaft of the humerus. These three portions unite about the middle of the arm, and form one powerful muscle. which is inserted into the olecranon process of the ulna at the elbow, It extends the forearm, and is the direct antagonist of the biceps and anterior brachial. It is supplied by the musculo-spiral nerve.

The **psoas magnus** (great loin muscle) is partly within the cavity of the abdomen, and emerges from the abdominal cavity beneath Poupart's ligament, in connection with the iliacus. It is attached to the spinal column (one on either side) from the last dorsal vertebra to the sacrum, and is inserted by a tendon, common to this and the iliacus, into the smaller trochanter of the femur. It rotates the thigh outward, and bends it upon the pelvis, or the pelvis upon the thigh. It is supplied by branches of the lumbar nerves.

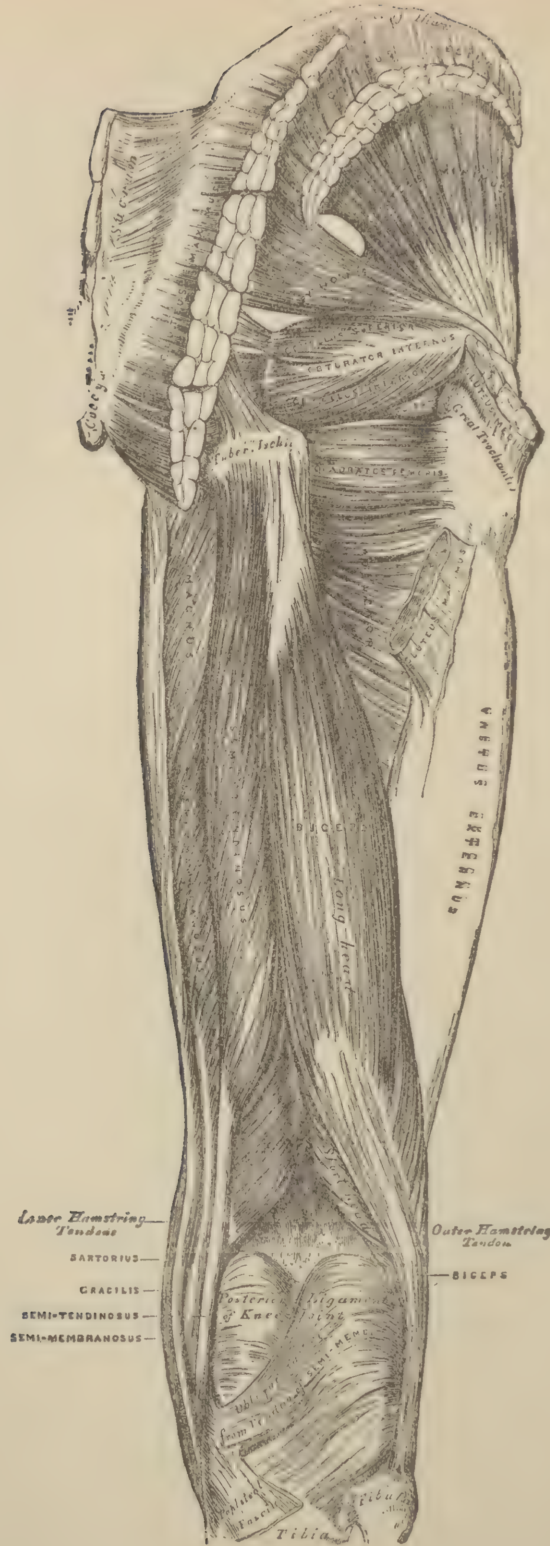
The **iliacus** (iliac muscle) occupies the internal iliac fossa, and blends below with the psoas magnus. It is supplied by the anterior crural nerve (the largest branch of the lumbar plexus). The lumbar plexus is formed by the anterior branches of the four upper lumbar nerves. The latter are spinal nerves.

The **sartorius** (tailor's muscle) extends from the ilium (from the anterior superior spine of the ilium) to the tibia (inner surface of the shaft near the crest, or shin). It is the longest in the body. (See muscles of the iliac, etc.) Near the groin it forms the outer bound-

Fig. 123.

MUSCLES OF THE ILIAC AND ANTERIOR FEMORAL REGIONS.

Fig. 124.



MUSCLES OF THE HIP AND THIGH.

ary of Scarpa's triangle. The latter is a triangular space formed by Poupart's ligament above and by the borders of two muscles (the sartorius and adductor longus) at its sides. In this triangle the femoral artery and femoral vein are quite superficial. The artery passes perpendicularly through the center of this space, and lies between the vein and the anterior crural nerve. The nerve is outside of the artery. The sartorius serves to cross the legs, as the tailor sits upon his bench. It is supplied by the anterior crural nerve.

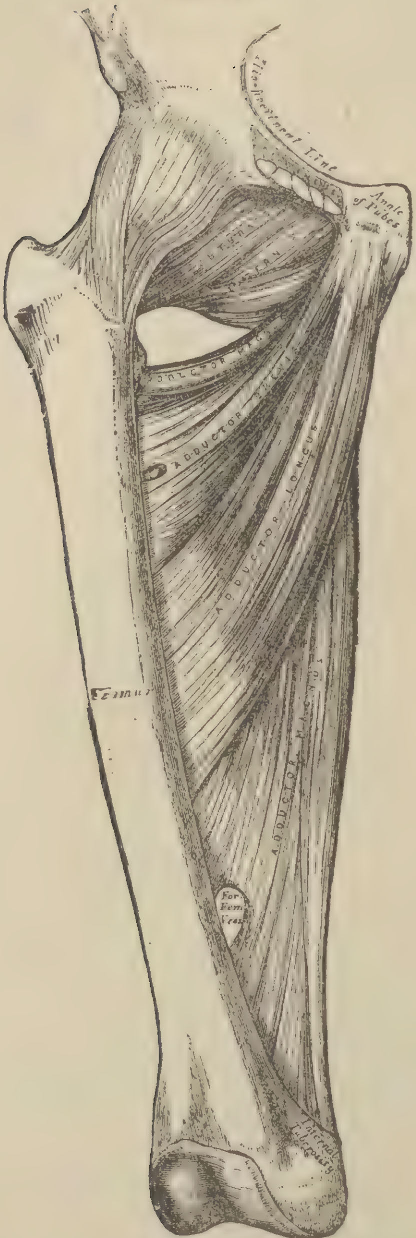
The **rectus femoris** (straight of the thigh) and **two vasti** (vastus internus and vastus externus) make up the **triceps extensor cruris**, or simply the triceps of the leg. It is the "kicking" muscle, or great extensor. The three parts are inserted by a common tendon into the patella at the knee, and through the patella and ligament (ligamentum patellæ) below into the tubercle of the tibia. The rectus has two origins, or two tendons, called the straight tendon and the reflected tendon. The straight tendon is attached to the anterior inferior spine of the ilium, and the reflected tendon to the upper border of the acetabulum. The vastus externus is attached to the whole length of the linea aspera, and to the anterior border of the great trochanter. The vastus internus is attached to the linea aspera and to the inner surface of the femur. These three muscles, uniting to form one tendon, are all governed by the anterior crural nerve.

The **biceps flexor cruris**, or biceps of the leg, is situated on the posterior part of the thigh. Its long head extends from the tuberosity of the ischium to the head of the fibula below the knee. Its short head is attached to the whole length of the linea aspera, between the adductor magnus and vastus externus. The fibers of the long head terminate in an aponeurosis, which covers the posterior, or outer surface of the muscle, and receives the fibers of the short head, which spring from the shaft (the linea aspera,—the rough posterior portion of the shaft) of the femur. The aponeurosis becomes gradually contracted into a tendon (the outer hamstring), which is inserted into the outer side of the head of the fibula, and embraces the external lateral ligament of the knee.

The three muscles (biceps, semimembranosus, and semitendinosus) forming the posterior femoral group, are all governed by the great sciatic nerve.

The office of the seven **orbital muscles** has already been given. They are all situated within the orbit and around the eyeball. All but one (the inferior oblique) have their origin at the back part of the orbit, behind the eyeball; and, again, all but one (the levator palpebræ) are inserted into the sclerotic coat of the eyeball. The inferior oblique arises from a depression in the orbital plate of the superior maxillary

Fig. 125.



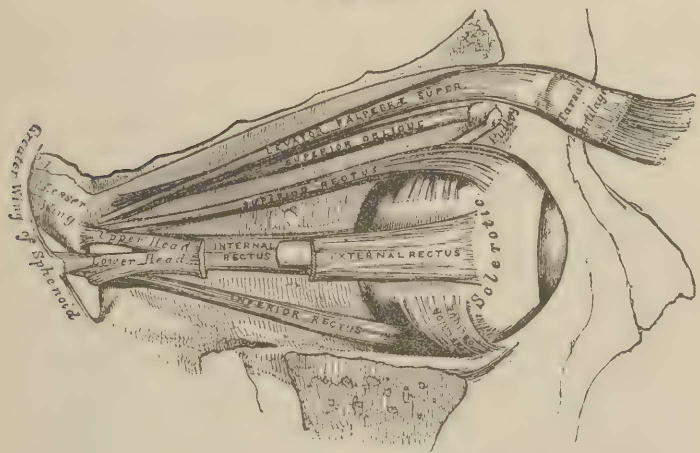
DEEP MUSCLES OF THE FEMORAL REGION—INNER SIDE.

bone, external to the lachrymal groove; and the levator palpebræ is inserted into the upper, or posterior border of the upper tarsal cartilage.

The four recti (superior, inferior, internal, and external rectus) muscles are situated, as their name implies, above, below, on the inner, and on the outer side of the eyeball, and are inserted into the sclerotic coat about one third of an inch (one centimeter) from the margin of the cornea (the cornea lies in front of the colored portion of the eye).

The superior oblique is situated at the upper and inner side of the orbit, internal to the levator palpebræ. It passes from the back part of the orbit forward to the inner angle of the eye, where it passes through a loop, or ring of fibro-cartilage, that acts as a pully to change its direction. From the pulley it passes outward above the eyeball, but beneath

Fig. 126.



MUSCLES OF THE ORBIT.

the superior rectus muscle to the outer part of the globe, where it is inserted into the sclerotic coat. When it contracts, it moves the *upper part* of the globe toward the median line of the body, or toward the other eye.

The inferior oblique passes outward beneath the eyeball and inferior rectus, between the external rectus and eyeball, to be inserted near the insertion of the superior oblique, which it antagonizes, or counterbalances. It rotates the *lower part* of the globe inward. These oblique muscles act spontaneously when we incline the head to one side, and thus confine the image of any object viewed to the same parts of the retina (the retina is a thin, semitransparent membrane that lines the interior of the eyeball, and surrounds the vitreous body. It receives the image of all objects viewed).

The superior oblique muscle is governed by the "pathetic" (fourth cranial) nerve; the external rectus by the "abducens" (the sixth cranial) nerve; and all the other orbital muscles by the "motor oculi" (mover of the eye, or "motores oculorum" [movers of the eyes], the third cranial) nerve.

The deep fascia of the thigh is the most extensive of all the deep fasciæ of the body, and is called the "**fascia lata**" (broad bandage). It

Fig. 127.

FASCIA LATA AND SAPHENOUS OPENING.

is also called the "vagina femoris" (sheath of the thigh). It envelopes all the muscles of the thigh, and sends off from its inner surface two strong intermuscular septa (divisions, or partitions between the muscles), which are attached to the whole length of the linea aspera ("rough line" on the back of the thigh-bone) and numerous smaller septa (walls), which separate the individual muscles, and inclose each

in a distinct sheath. The fascia lata covers the entire thigh, from the crest of the ilium and Poupart's ligament to the knee. It is thickest at the upper and outer side of the thigh. At the upper and inner part of the thigh (a little below Poupart's ligament) it has a large, oval-shaped aperture (the "saphenous opening"), which transmits the internal saphenous vein to the femoral vein. It is through this opening that a femoral hernia (protrusion of the bowel) passes, after descending along the crural (or femoral) canal. It is about an inch and a half (three or four centimeters) in length and half an inch (one or two centimeters) in width. The layer of superficial fascia that covers the saphenous opening is called the *cribriform* (sieve-like) *fascia*, because it is pierced, or perforated by numerous openings for blood-vessels and lymphatics.

The deep fascia of the arm forms one continuous covering of the shoulder, arm, and forearm, investing the muscles, and sending down septa (divisions) to separate the muscles from each other. Numerous apertures exist in the fascia for the passage of arteries, veins, and nerves.

The **palmar fascia** (bandage of the palm) covers and invests the muscles of the hand. It adheres firmly to the integument by numerous fibrous bands, and is thick and strong. Four slips extend upon the fingers, and inclose the tendons of the flexor muscles.

The **superficial fascia of the thorax** is continuous with the fascia of the neck and upper extremities above and of the abdomen below. Opposite the mammary gland it divides into two layers, which inclose the gland, and send septa (partitions) into its substance to support the various lobes. It communicates with the deep fascia which invests the pectoral muscles.

MUSCLES THAT MOVE THE THUMB AND FINGERS.

In each hand there are 35 tendons, that move the thumb and fingers. These tendons belong to 26 different muscles with 18 different names. There are 5 flexors, 6 extensors, 2 abductors, 2 adductors, 3 palmar interossei, 4 dorsal interossei, and 4 lumbricales. Three of these muscles (the flexor sublimis digitorum, flexor profundus digitorum, and extensor communis digitorum) have each 4 tendons — 1 to each finger; the rest, 1 each. The tendons of the flexor sublimis digitorum (high flexor of the fingers) are perforated by the tendons of the deep flexor (flexor profundus digitorum). The names of these muscles are as follows: —

Fig. 128.

MUSCLES OF THE LEFT HAND — PALMAR SURFACE.

1. Flexor sublimis digitorum (high flexor of the fingers).

2. Flexor profundus digitorum (deep flexor of the fingers).

3. Flexor ossis metacarpi pollicis, or opponens pollicis (flexor of the metacarpal bone of the thumb, or opponent of the thumb: it draws the thumb inward to meet the little finger).

Fig. 129.

MUSCLES OF THE FRONT OF THE FOREARM.

1. Biceps.
2. Brachialis Anticus.
3. Supinator Longus.
4. Pronator Radii Teres.
5. Flexor Carpi Radialis.
6. Palmaris Longus.
7. Flexor Carpi Ulnaris.
8. Flexor Sublimis Digitorum.
9. Flexor Longus Pollicis.

4. Flexor brevis pollicis (short flexor of the thumb).

5. Flexor longus pollicis (long flexor of the thumb).

6. Extensor communis digitorum (common extensor of the fingers).

7. Extensor ossis metacarpi pollicis (extensor of metacarpal bone of the thumb).

8. Extensor primi internodii pollicis (extensor of the first bone of the thumb).

9. Extensor secundi internodii pollicis (extensor of the second, or last bone of the thumb).

10. Extensor indicis (extensor of the index finger).

11. Extensor minimi digiti (extensor of the little finger).

12. Abductor pollicis (abductor of the thumb).

13. Abductor minimi digiti (abductor of the little finger).

14. Adductor pollicis (adductor of the thumb).

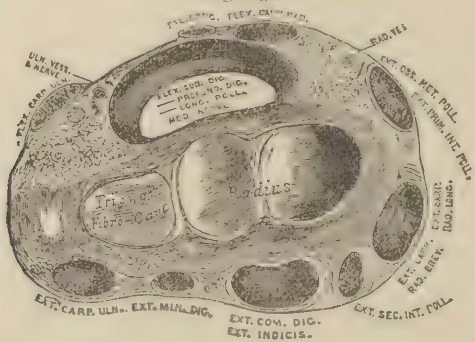
15. Opponens minimi digiti (opponent of the little finger).

16. Three palmar interossei (between the bones of the palm).

17. Four dorsal interossei (between the bones of the back of the hand).

18. Four lumbricales (" earthworms," from their shape).

Fig. 130.



TRANSVERSE SECTION THROUGH THE WRIST, SHOWING THE CANALS FOR PASSAGE OF THE TENDONS.

The thumb has three extensors — one for each bone, and one for the bone (metacarpal) at its base; these occupy the back of the fore-arm and hand. It has also three flexors on the palmar surface, an abductor, and an adductor.

The fingers are flexed by the flexor sublimus digitorum (high flexor of the fingers) and flexor profundus digitorum (deep flexor of the fingers); and are extended by the extensor communis digitorum (common extensor of the fingers).

The flexor sublimis digitorum (high flexor of the fingers) arises at the elbow from the inner condyle of the humerus, coronoid process of the ulna, and from the radius below its tubercle. At the lower third of the forearm it divides into four tendons, which pass together beneath the annular ligament of the wrist, to be inserted into the base of the bones of the second phalanx. Opposite the bones of the first phalanx

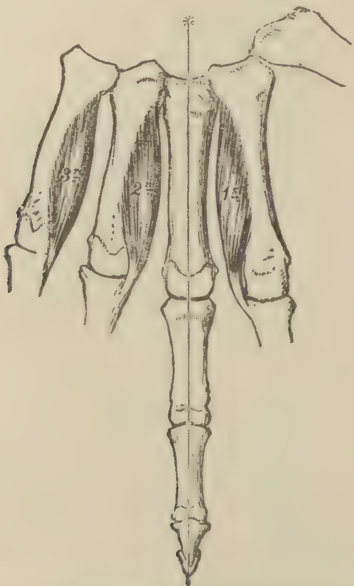
Fig. 131.

FRONT OF THE LEFT FOREARM — DEEP MUSCLES.

the tendons are split ("perforatus"—perforated), to give passage to the four tendons of the deep flexor. The tendons of the latter are inserted into the base of the bones of the first phalanx. The deep flexor of the fingers (flexor profundus digitorum) arises from the upper two thirds of the ulna and from the interosseous membrane, and divides into four tendons at the middle of the forearm. The little finger has sometimes a special flexor (flexor brevis minimi digiti, or, simply, flexor minimi digiti). It arises from the unciform bone at the wrist, and is inserted into the base of the first bone of the little finger.

The extensor communis digitorum (common extensor of the fingers) arises from the external condyle of the humerus at the elbow, and below the middle of the forearm divides into four tendons, which pass beneath

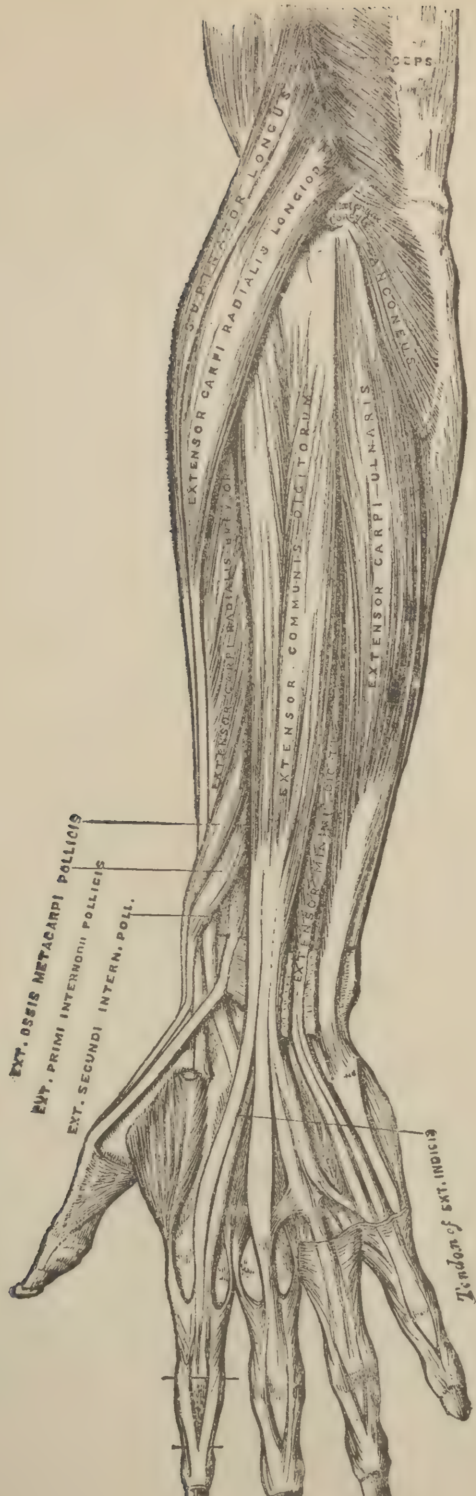
Fig. 132.



PALMAR INTEROSSEI OF THE LEFT HAND.

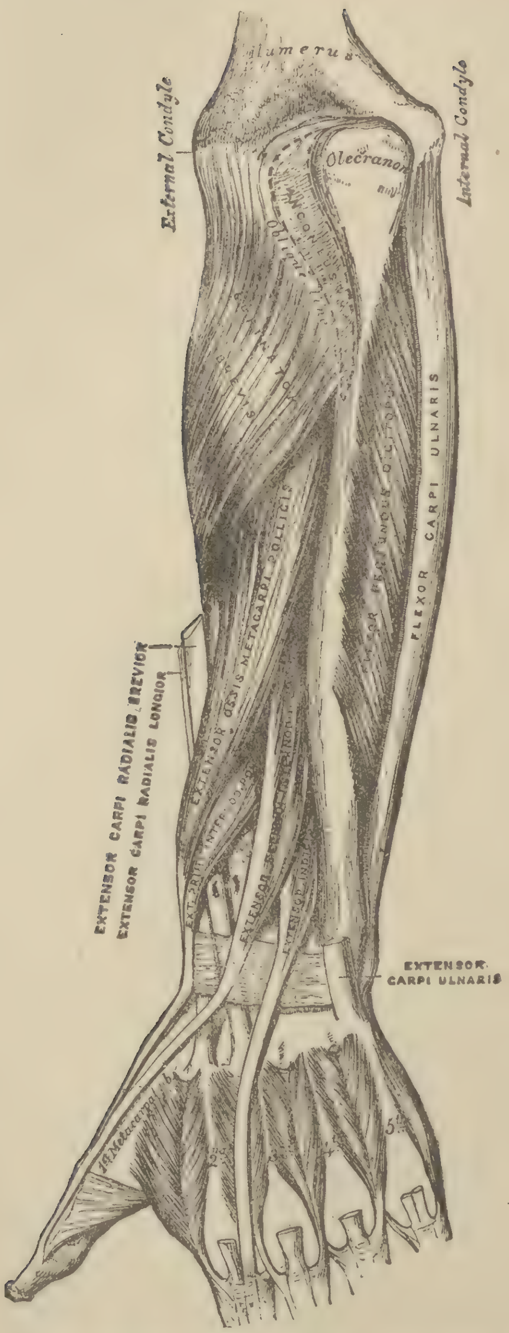
the annular ligament on the back of the wrist, to be inserted into the second and third phalanges of the fingers. As they pass over the first phalanges, they receive fibers at the sides, from the lumbrical and interosseous muscles. On the back of the hand, the tendons of the middle, ring, and little finger are connected by oblique tendinous slips, which associate their action much more than with the other tendon (to the index finger). The extensor indicis extends the index finger, and the extensor minimi digiti extends the little finger. The four lumbricales are accessories to the deep flexor muscle. They (lumbri-

Fig. 133.



MUSCLES ON THE BACK OF THE FOREARM.

Fig. 134.



POSTERIOR SURFACE OF THE FOREARM — DEEP MUSCLES.

cales) arise from the tendons of the deep flexor, and are inserted into the aponeurosis of the extensor tendon on the radial side of the fingers. They were called by the earlier anatomists, "fiddlers' muscles."

The three palmar interossei arise from the base of the metacarpal bone of one finger, and are inserted into the base of the first bone (first phalanx) of the same finger. The middle finger has none.

The four *dorsal interossei* (between the bones) arise by two heads from adjoining sides of the bases of the metacarpal bones, and are

Fig. 135.

DORSAL INTEROSSEI OF THE LEFT HAND.

inserted into the base of the bones of the first phalanx. In relation to the axis of the hand, they are abductors,—the first and second abducting the index and middle finger toward the thumb, or radial side, the other two abducting the middle and ring finger toward the *little* finger, or ulnar side; *i. e.*, the middle finger has two dorsal interossei, one on each side, the index finger has one on the radial side, the ring finger one on the ulnar side, and the thumb and little finger none. The palmar interossei adduct (with reference to the axis of the hand) the index, ring, and little finger.

ANGIOLOGY (VESSEL-STUDY).

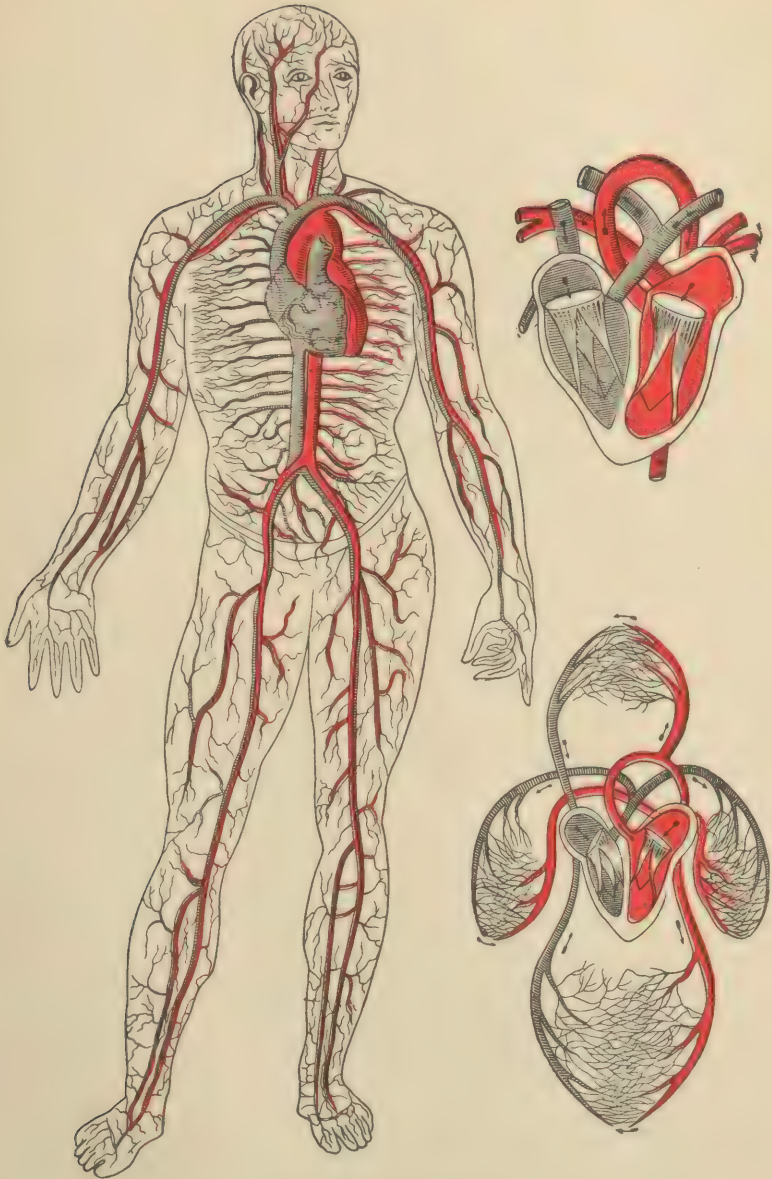
THE vessels of the body are the arteries, capillaries, and veins, which carry blood, and the lymphatics, which carry lymph (a clear fluid), or chyle ("juice,"—applied to the nutritive fluid). The special lymphatic vessels that carry chyle are named lacteals.

Between the arteries and veins,—*i. e.*, where the arteries end and the veins begin,—are the capillaries, and where the veins end and the arteries begin, is the heart; or if we commence at the heart, and trace the course of the blood throughout the system to the heart again, we shall find that it flows successively through the heart, arteries, capillaries, and veins. The lymphatics convey lymph and chyle into the blood.

The blood, like the muscles, moves under the control of the nerves; but, unlike the action of the voluntary muscles, the blood moves, not directly in obedience to the human will, but in obedience to the soul; or, in other words, the emotions (propellers). The special nerves that control the circulation of the blood are called the vaso-motor (vessel-moving) nerves. They arise from the gray matter of the medulla, and the sympathetic ganglia.

The heart is sometimes described with the organs of the chest, or with the viscera; but, being the great central organ of the circulation, it is properly described in connection with the blood-vessels. The heart is situated obliquely in the chest, between the lungs. It occupies the middle part of the space between the two pleuræ (membranes that invest each lung, separately), which is called the mediastinum. The heart is of conical form, and has its base directed upward, backward, and toward the right. Its average dimensions, in inches, are 5, 3½, and 2½; or in centimeters, about 13, 9, and 7. Its average weight is about 10 ounces; varying in the male from 10 to 12 ounces, and in the female from 8 to 10 ounces. In proportion to size of body, the female heart is larger. In grams, the average weight of the heart is 311—342 in the male, and 280 in the female.

The heart is covered in front by the lower part of the sternum (breast-bone), and by the cartilages of the third, fourth, and fifth ribs, but is separated from the chest-wall, except a small area, by lung-tissue. It lies mostly to the left of the median line of the body. Its apex is

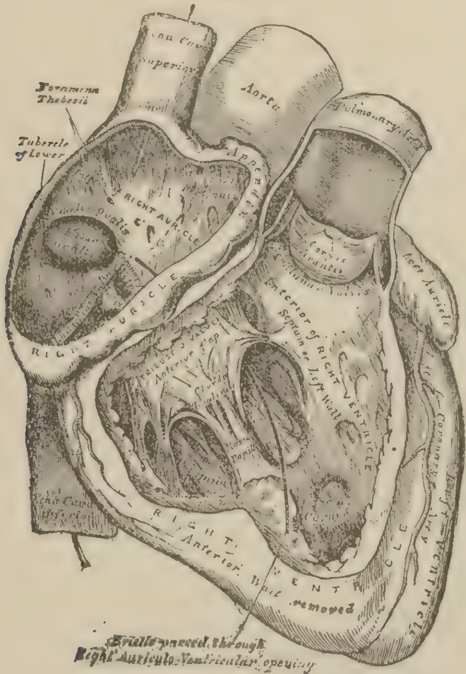


SYSTEMIC CIRCULATION.

(Opp. Page 202).

directed forward, and to the left, and occupies the fifth intercostal space (space between the ribs). The heart is divided by a muscular septum (partition) into two lateral halves, named respectively the right and left sides of the heart; but the heart is so obliquely placed, not only as to the general direction of the heart with reference to a vertical line, but also with reference to the muscular septum and sides of the body, that the "right side" of the heart really occupies the greater part of its *anterior* portion; while the "left side" occupies largely its *posterior* portion, but extends somewhat farther to the left than the right side of the heart.

Fig. 136.



RIGHT AURICLE AND VENTRICLE.

Each side of the heart contains an auricle and ventricle. The right auricle and right ventricle are in the right side of the heart, and the left auricle and ventricle in the left side. In passing from the right side of the heart to the left side, the blood is compelled, in the adult, to pass through the lungs. In fœtal life, when no air reaches the lungs, the blood passes through an opening (the foramen ovale) in the muscular septum, directly from the right to the left side of the heart. Soon after birth the foramen ovale generally becomes closed.

The heart is wholly inclosed by a serous membrane, called the pericardium ("around the heart"), or heart-case. Within this encasement the heart moves freely. The pericardium extends upward, and surrounds the great vessels (the aorta, the pulmonary artery and veins, and the superior vena cava), about two inches (five centimeters) above their origin at the heart. The pericardium is of conical form, having its apex above the base of the heart, and its base attached to the central tendon of the diaphragm below the apex of the heart. The inferior vena cava pierces the pericardium through the central tendon of the diaphragm, and receives no covering from the external layer of the pericardium.

The right side of the heart is the venous side, receiving into its auricle from the coronary sinus and venæ cavæ (the superior and inferior vena cava) the dark, venous blood from the entire body. From the right auricle the blood passes through what is called the "auriculo-ventricular orifice" (orifice connecting the auricle and ventricle) into the right ventricle; and from the right ventricle, through the pulmonary artery to the lungs.

The aerated, or arterialized blood from the lungs is returned to the heart, but to the left side instead of the right, by the pulmonary veins (usually four in number), and is received by the left auricle (two veins opening on either side of the auricle). From the left auricle the blood passes through the auriculo-ventricular orifice of the left side of the heart into the left ventricle, and from the left ventricle through the aorta and its branches to the capillaries of every part of the entire body. From the capillaries the blood is returned to the heart again, by the veins, every minute or two of a person's life, going out in the arteries and back in the veins; and this constitutes the circulation of the blood.

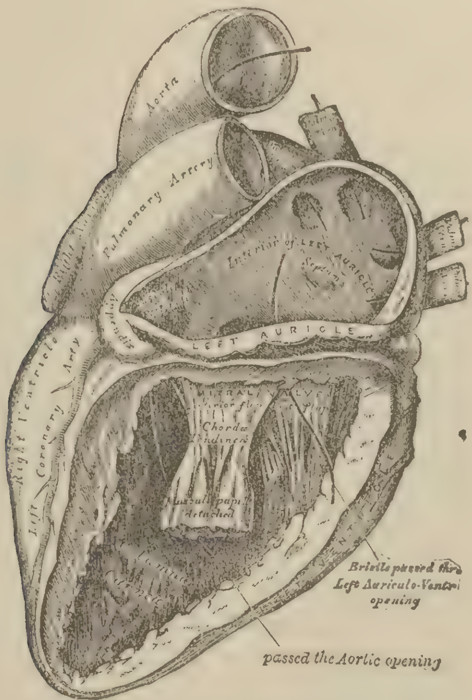
The auricles (little ears, or receivers) receive the blood; the ventricles (little bellies, or cavities) expel it. The auricles occupy the upper portion of the heart, and the ventricles the lower portion (the apex of the heart).

The auriculo-ventricular orifice on either side of the heart is guarded by a valve—the mitral on the left, and the tricuspid on the right. The venous blood passes through the tricuspid valve; the arterial blood through the mitral valve. The entrance to the pulmonary artery, and also to the aorta, is guarded by a semilunar valve. The word valve, as used by different authors, is somewhat indefinite. It may mean a folding door, or one of the leaves of a folding door. It is here used in the former sense. The mitral valve (resembling the top of a bishop's miter [head-dress]) has two leaves; the tricuspid (three points) and semilunar (half-moon) each three leaves.

The valves are all formed by a duplicature of the lining membrane of the heart. This membrane is continuous with the lining membrane of the great blood-vessels, and is called the "endocardium" (within the heart).

The Eustachian valve (named from Bartholomew Eustachius, who died at Rome in 1570, A. D.) is semilunar in form, has a single crescent-shaped fold, and is situated at the junction of the inferior vena

Fig. 157.



LEFT SIDE OF THE HEART AND COMMENCEMENT OF THE LARGE ARTERIES, SHOWING THE LEFT AURICLE AND VENTRICLE.

cava with the right auricle. In the fœtus it is large, and serves to direct the blood through the foramen ovale (oval opening) into the left auricle. In the adult it is usually small, or altogether wanting.

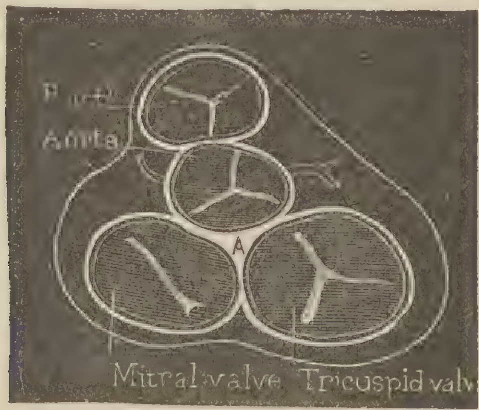
The coronary valve protects the orifice of the coronary sinus during the contraction of the auricle. The coronary sinus (bay or gulf) returns blood from the substance or walls of the heart.

The anterior cardiac veins and the venæ Thebesii (veins of Thebesius) open directly from the substance of the heart into the right auricle.

The free margins of the folds, or leaves that form the mitral and tricuspid valves are attached, by means of the chordæ tendinæ (heart-strings), either to the columnæ carneæ (fleshy columns), or directly to the walls of the ventricles.

Behind the three leaves, or flaps of the semilunar valve that guards the entrance to the pulmonary artery, are three pouches, or dilatations, which allow the folds of the valve to retire within these recesses in the coats of the vessel, and thus give an uninterrupted course to the current of blood. These recesses are called the "sinuses of Valsalva." Similar recesses are provided for the three folds of the semilunar valve, at the commencement of the aorta.

Fig. 138.



RELATIVE POSITION OF THE VALVES OF THE HEART — SEEN FROM ABOVE.

Altogether, the valves of the heart are three in kind, but six in number. Including the Eustachian and coronary, which are semilunar in form, there are four semilunar valves; there is also one mitral and one tricuspid.

The mitral and the tricuspid valves guard the entrance to the ventricles, and prevent the return of blood into the auricles; the semilunar valves guard the entrance of the great arteries (the pulmonary and aorta), and prevent the return of blood into the ventricles; the Eustachian prevents the return of blood into the inferior cava; and the coronary prevents the return of blood into the coronary sinus, which forms the entrance of the great cardiac and posterior cardiac veins.

The veins of Thebesius are also called venæ cordis minimæ (smallest veins of the heart). ("Cor," genitive, "cordis," is the Latin for heart, and "cardium" is the Greek term).

The auricles receive the blood through three or more openings,

and transmit it by a single opening into the ventricle below. The ventricles have each two openings only,— one from the auricle on either side of the heart, and one into the great artery (the pulmonary, on the right side of the heart, and the aorta, on the left). The right auricle has more numerous openings than the left. The latter has the openings from the pulmonary veins (usually four, but may be three or five), and an opening through the mitral valve into the left ventricle. The right auricle has three *large* openings,— two from the venæ cavæ (two largest veins in the body), and one through the tricuspid valve into the right ventricle, and *several smaller openings* for the coronary sinus and venæ cordis minimæ (smallest veins of the heart).

The fossa ovalis (oval depression) marks the situation of the foramen ovale (oval opening) in the fœtus (the unborn child; pronounced fetus). It is situated at the lower part of the muscular septum, between the auricles and above the orifice of the inferior vena cava. In many cases a small, slit-like opening exists between the auricles of the adult, showing an imperfect closure of the foramen ovale.

The tuberculum Loweri (tubercle of Lower) and the musculi pectinati (comb-teeth muscles) of authors are of minor importance, so far as relates to an understanding of the circulation.

The heartstrings (chordæ tendinæ) are the stays of the tricuspid and mitral valves, and prevent the leaves or segments of the valves from being carried or pushed back into the auricles.

The cavity of the right auricle, when moderately distended, contains 59 c.c. (about two ounces) of blood: (c.c. is the abbreviation for cubic centimeter. It is a cube whose side is one hundredth of a meter. The meter is almost 40 inches, or, more exactly, 39.37). The left auricle is a little smaller than the right.

The superior vena cava, returning the blood from the upper half of the body, opens into the upper and front part of the right auricle; while the inferior vena cava opens into the lowest part of the same cavity.

The right ventricle extends from the right auricle to the apex of the heart (minus the thickness of its walls), and forms the larger part of the front of the heart. Its under surface rests upon the diaphragm. At its upper part the right ventricle has a conical prolongation, called the "infundibulum" (funnel-shaped), or "conus arteriosus" (arterial cone), from which arises the pulmonary artery.

The left ventricle is longer than the right, and its walls are thicker, but it contains about the same quantity of blood. It forms a considerable portion of the posterior surface, and a small part of the left side of the anterior surface of the heart. The muscular fibers of the auricles and those of the ventricles are quite independent of each other.

The nerves of the heart belong to both the spinal and sympathetic system. The heart is also furnished with ganglia (nerve centers).

The arteries *always* carry blood from the ventricles of the heart; the veins carry blood toward the auricles of the heart. The arteries *generally* carry arterial blood, and the veins venous blood; but to this there are two exceptions,—one in the pulmonic circulation of the adult, the other in the fœtal circulation. The pulmonary artery of the adult, and the umbilical, or hypogastric arteries of the fœtus, carry venous blood; while the pulmonary veins of the adult and the umbilical vein of the fœtus carry arterial blood.

All the arteries of the body are branches of either the pulmonary artery or of the aorta, these being the only vessels that carry blood directly from the ventricles of the heart.

The names of arteries generally indicate prominent parts to which they are distributed, or parts and organs which they supply with blood. The same is true of the veins; their names generally indicate the parts from which they return blood to, or toward, one of the auricles of the heart.

Blood-vessels (arteries and veins) are found in all parts of the system, except the hair, nails, epidermis, cartilage, and the cornea (anterior covering) of the eye. A very minute artery takes the name of arteriole. The arterioles join the capillaries. The large blood-vessels are generally deep-seated, and well protected from injury. As a rule, the large vessels are straight; but where provision is needed for the extension of the part, the vessels are tortuous, that they may not restrict the movement. The internal carotids, the facial, and the vertebral arteries are examples of tortuous vessels.

The smaller arteries and veins communicate freely with each other by what is termed anastomosis, or inosculation. Both words have the same meaning — one being derived from the Greek and the other from the Latin. Either term signifies that two or more vessels communicate with each other, so that when the blood is obstructed or arrested in one vessel it can proceed along other vessels, and thus reach parts beyond the obstruction. The circulation through such unusual channels is called "collateral circulation." In some instances large arteries communicate (inosculate) with each other. The circle of Willis in the brain, and the arteries of the mesentery, hand, and foot, are examples of inosculation of large arteries. The arteries and veins all inosculate in the capillaries of the system.

The arteries and veins have three coats,— internal, middle, and external. The internal coat is epithelial; the middle, elastic, and more or less muscular; and the external coat cellular, or connective. The

external coat is firmer than the two inner, so that a ligature may be applied with sufficient pressure to divide one or both of the other coats without injury to the external coat. In the largest arteries the middle coat is very thick, and highly elastic, but becomes thinner as the vessels decrease in size.

The walls of the blood-vessels (arteries and veins) are themselves supplied with blood-vessels, like other organs. These nutrient vessels are called vasa vasorum (vessels of vessels). They arise from a branch of the same vessel, or from a neighboring vessel.

The vaso-motor (vessel-moving) nerves are derived chiefly from the sympathetic, but partly from the cerebro-spinal system, or, at least, are intimately connected with the latter.

The larger arteries and veins are surrounded by a prolongation of fascia, which forms a sheath for them. The sheath usually incloses the accompanying vein or veins, and sometimes a nerve.

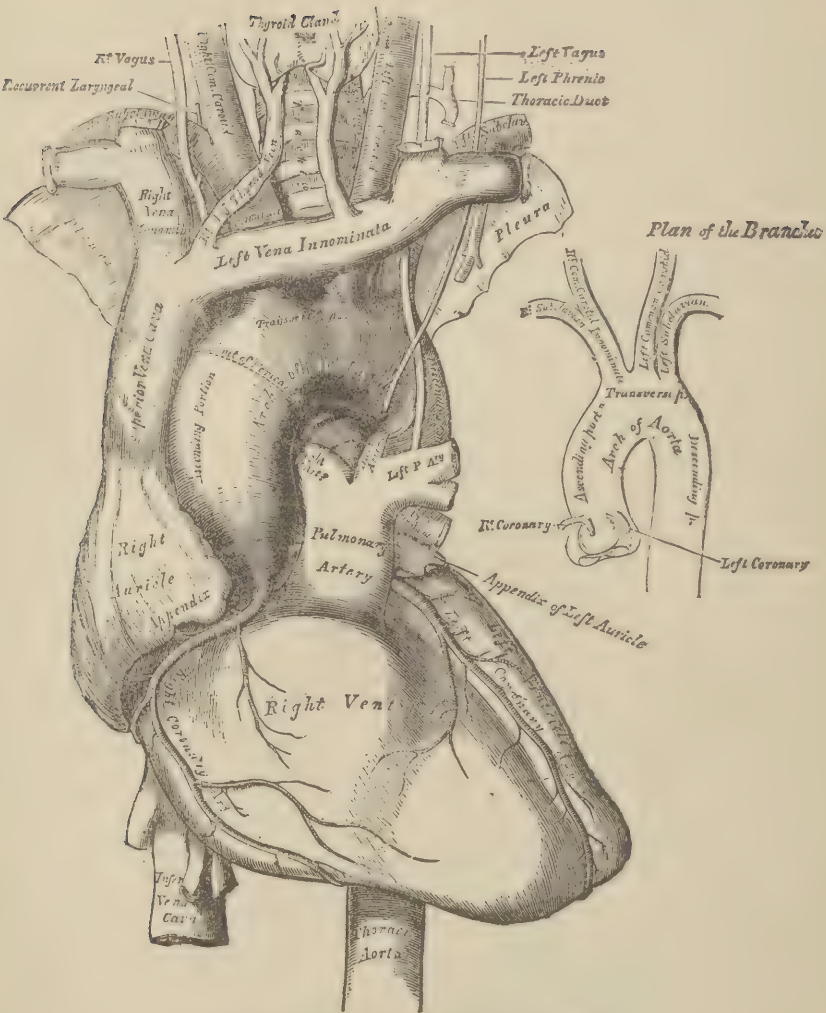
The capillaries are minute microscopic tubes, situated between the arteries and veins, which they serve to connect. Their usual diameter is .008 mm. ($\frac{8}{1000}$ of a millimeter $= \frac{1}{3000}$ of an inch). The smallest capillaries are those of the brain. The number of the capillaries and the size of the interspaces determine the degree of vascularity of a part. The closest network is found in the lungs. As a general rule, the more active the function of an organ the closer is the capillary network, and the larger the supply of blood. The network is narrow in the glands and mucous membranes; wider in bones and ligaments, which are comparatively inactive, and nearly or quite absent in tendons and cartilage, in which little change occurs after their formation.

THE ARTERIES.

The **aorta** (called also arteria magna,—"great artery") is the main trunk of all the vessels which convey red, oxygenated blood to every part of the body. The term "aorta" signifies "arising from." It arises from the left ventricle of the heart; passes obliquely upward and forward toward the right; arches backward to the left, over the root of the left lung; descends within the thorax, on the left of the vertebral column, or median line; passes through the diaphragm in front of the vertebral column into the abdomen, and terminates a little above the pelvis (opposite the fourth or fifth lumbar vertebra) in two large branches,—the common iliac arteries,—which, on account of their situation at the end of the aorta, are termed terminal branches.

The entire number of branches given off by the aorta during its entire course is about sixty; but they are described under nineteen

Fig. 139.



ARCH OF THE AORTA, AND ITS BRANCHES.

heads, or terms — eighteen besides the common iliac arteries. These will be given further on.

For convenience of description, the aorta is divided into parts, or portions. Those portions, contained respectively in the thorax and abdomen, are named the "thoracic" and the "abdominal" aorta. These are subdivided. The first part of the thoracic aorta is called "the arch," because it forms a bow. Again, the arch itself is described in three segments, named respectively the ascending, transverse, and descending portions. The ascending portion is about five centimeters (two inches)

long, and is contained in the cavity of the pericardium (heart-case). It gives off to the substance of the heart the coronary (or cardiac) arteries at the commencement of its course. Two other coronary arteries, branches of the facial, carry blood to the upper and lower lips. The transverse portion of the arch lies obliquely in the chest, passing backward toward the left side. It lies three or four centimeters (one or two inches) below the upper margin of the sternum (breast-bone), and is seven centimeters (about three inches) long. This portion (the transverse) of the arch usually gives off three large trunks,—the innominate, the left common carotid, and the left subclavian arteries. The descending portion of the arch passes downward along the bodies of the third and fourth dorsal vertebræ, and becomes the thoracic aorta (often so called, although all above the diaphragm is properly thoracic), which extends to the diaphragm.

The abdominal aorta extends from the diaphragm to its bifurcation (division into two branches), just above the brim of the pelvis.

The branches of the aorta are as follows:—

1. Coronary, 1 to 4 in number, usually 2—the right and left coronary. These supply the substance of the heart.

2. Innominate, or brachio-cephalic ("arm and head" on the right side).

3. Left common carotoid (to the left side of the head).

4. Left subclavian (to the left upper extremity).

5. Œsophageal, 4 or 5 in number (œsophagus).

6. Pericardiac, irregular in number (heart-case).

7. Bronchial, usually 3, possibly 1 (lungs).

8. Posterior mediastinal, several small ones.

9. Aortic intercostals, 9 or 10 on either side (between the ribs).

All the above are given off above the diaphragm, and the first four from the arch.

Below the diaphragm (or from the abdominal aorta) we have:—

10. Inferior phrenic, 2 (below the diaphragm).

11. Cœliac axis, very soon dividing into the gastric (stomach), hepatic (liver), and splenic (spleen) arteries.

12. Superior mesenteric, 1 (small intestine and part of the large).

13. Supra-renal, 2 (supra-renal capsules).

14. Renal, 2 (kidneys).

15. Spermatic, 2 (testicles).

16. Inferior mesenteric, 1 (lower part of the large intestine).

17. Lumbar, 8 in number (loins).

18. Sacra media, 1 ("middle of the sacrum." It supplies the posterior surface of the rectum, and terminates in what has been called "Luschka's gland.")

19. Common iliac, 2 (to the lower extremities).

The **innominate artery** is the largest branch given off from the arch of the aorta. It ascends four or five centimeters (about two inches), and divides into two branches,—the right common carotid and right subclavian. It is separated from the sternum in front by two muscles (sterno-hyoid and sterno-thyroid), by the remains of the thymus gland and by the left innominate vein. Occasionally the innominate artery is absent; in which case the right common carotid and right subclavian arise *separately* from the arch of the aorta, giving four instead of three large trunks from the transverse portion of the arch.

The **left common carotid** artery arises from the highest part of the arch, near the origin of the innominate, and is longer than the right common carotid, which springs from the innominate. Within the thorax the left common carotid lies just in front of the trachea, œsophagus, and thoracic duct. In the neck, the two common carotids occupy, on either side, a nearly similar position. They extend upward to the upper border of the thyroid cartilage (Adam's apple), where each bifurcates, and forms the external and internal carotid arteries. Each common carotid in the neck lies *without* the pharynx, larynx, and trachea, and *within* the internal jugular vein.

The sheath of the common carotid incloses also the pneumogastric nerve and the internal jugular vein. The nerve lies between and behind the other two.

The right and left subclavian arteries carry blood to the upper extremities. The **left subclavian** is a branch of the aorta; the right, a branch of the innominate (when the innominate is present).

The **œsophageal arteries**, four or five in number, arise from the front of the aorta, and pass obliquely downward to the œsophagus, where they anastomose with branches of the inferior thyroid, phrenic, and gastric arteries.

The **pericardiac arteries**, irregular in number and small in size, supply the pericardium (heart-case).

The **bronchial arteries** are the nutrient vessels of the lungs. They vary in number, from one to three. That of the right side (to the right lung) sometimes arises from the first aortic intercostal, but they may all arise from the aorta.

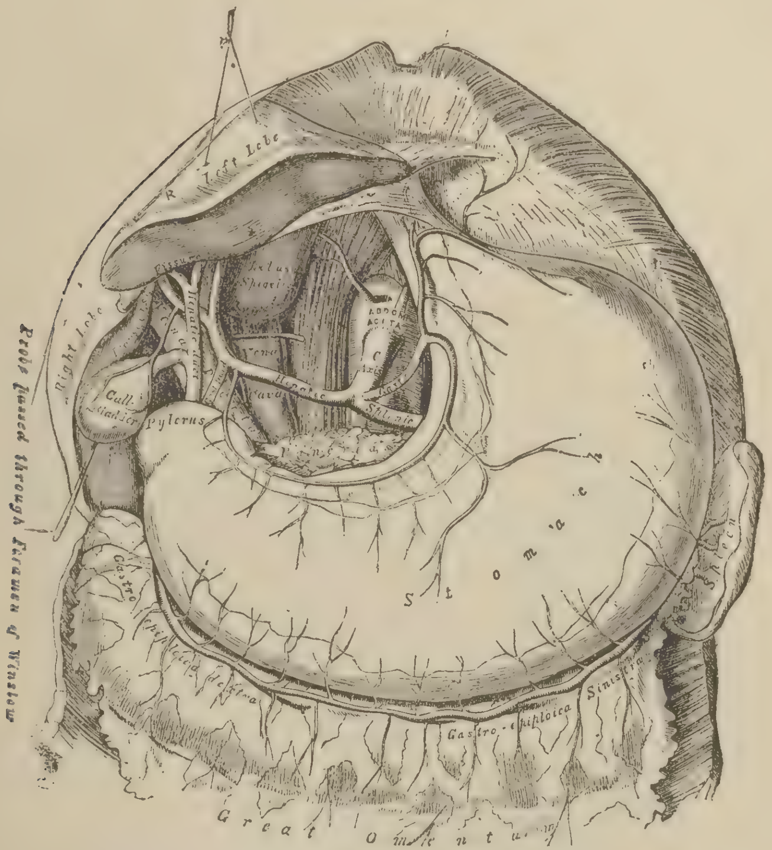
The **posterior mediastinal arteries** are small vessels that supply glands and connective tissue in the mediastinum.

The **aortic intercostal arteries** (the last to be mentioned of the thoracic branches) supply the intercostal muscles, and anastomose (communicate) with branches of the internal mammary and axillary arteries. They are usually ten in number on each side, the upper intercostal space

being supplied by a branch of the subclavian artery. (The branch supplying the upper intercostal space is called the *superior intercostal artery.*)

The **phrenic arteries** supply the diaphragm and some neighboring parts with blood.

Fig. 140.



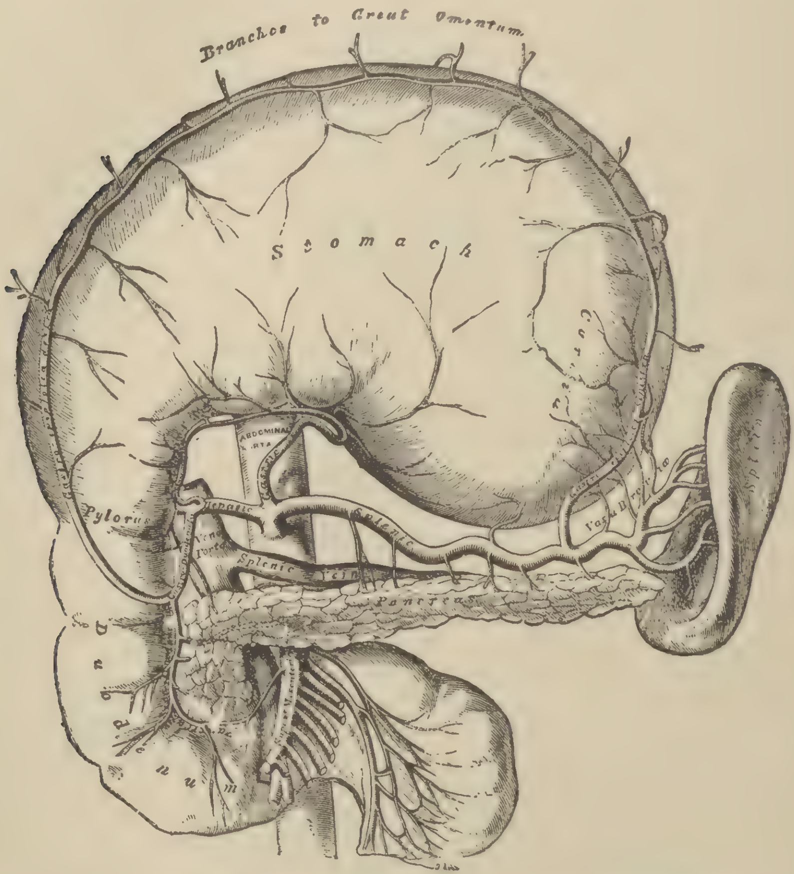
THE CŒLIAC AXIS, AND ITS BRANCHES.

Those derived from the aorta are termed **inferior phrenic,** to distinguish them from other phrenic arteries derived from the internal mammary.

The inferior phrenic arteries, two in number, sometimes arise from the aorta, or cœliac axis, by a common trunk; or one may spring from one of the renal (kidney) arteries. They diverge across the crura (legs) of the diaphragm, and pass upward and outward upon its under surface.

The **cœliac** ("cœlum," sky, or heavens; because the diaphragm forms an arch, or vault, over the abdomen, like the sky above the earth: hence, cœliac relates to the abdomen) **axis** is a short, thick trunk, about one or two centimeters (half an inch) in length, arising from the aorta in front, and, passing directly forward, divides into three branches

Fig. 141.

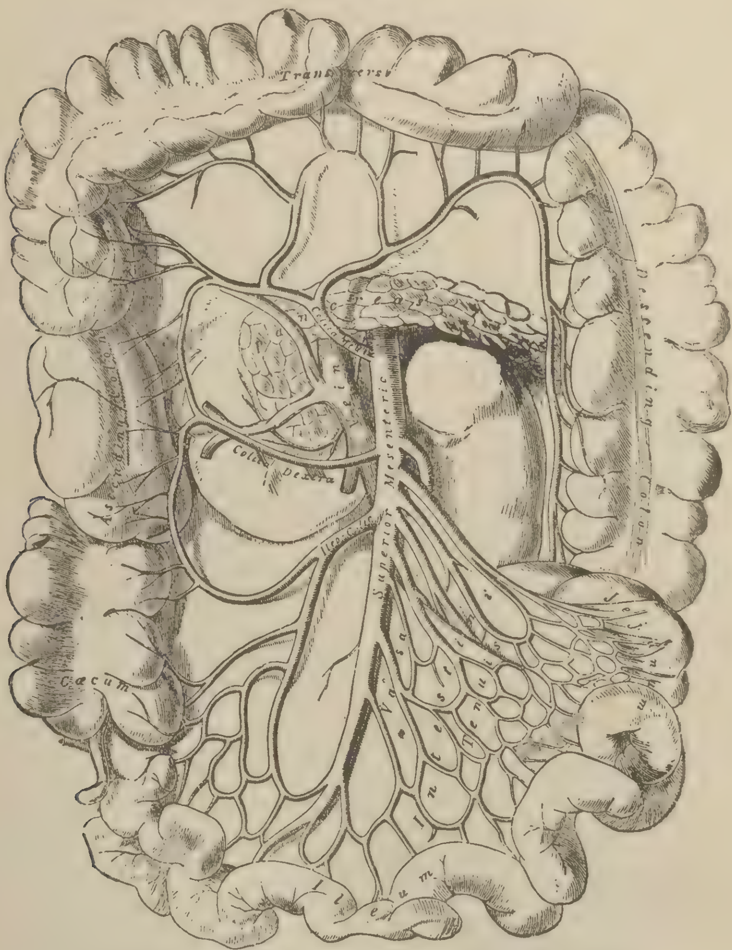


CŒLIAC AXIS AND BRANCHES IN CONNECTION WITH THE STOMACH AND SPLEEN.

(gastric, hepatic, and splenic arteries), which supply the stomach, liver, and spleen. **The splenic is the largest of the three.** The splenic and hepatic arteries both send branches to the stomach, also. The gastric (stomach) artery extends along the lesser curvature of the stomach from the cardiac to the pyloric orifice, and inosculates with branches of the splenic and hepatic arteries.

The **superior mesenteric** (upper middle intestine) **artery** is a vessel of large size. It arises from the aorta, just below the cœliac axis, passes forward in front of the duodenum (small bowel just below the stomach), and descends between the layers of the mesentery (folds of peritoneum [a serous membrane that lines the abdominal cavity and in-

Fig. 142.



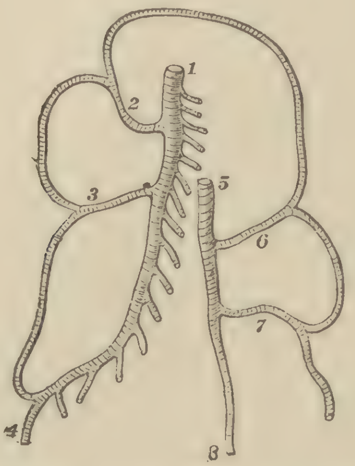
SUPERIOR MESENTERIC ARTERY, AND ITS BRANCHES.

vests the bowels]) toward the right iliac fossa, giving off numerous anastomosing branches to the bowels. This artery (the superior mesenteric) supplies the whole length of both the small and large bowels, except a part of the small bowel near the stomach and the lower part of the large bowel. The descending colon, sigmoid flexure, and rectum, are

supplied mainly by the inferior mesenteric artery, which is smaller than the superior, and descends toward the *left* iliac fossa.

The **inferior mesenteric artery** arises from the left side of the aorta, three or four centimeters (one or two inches) above its division into the common iliacs, and after supplying the descending colon and sigmoid flexure, descends into the pelvis, under the name of the superior hemorrhoidal artery, which supplies, in part, the rectum. The trunk of the latter artery divides at the middle of the sacrum, about a finger's length from the anus, which is the limit of safety in dividing the rectum during any necessary surgical operation.

Fig. 143.



1. Superior mesenteric a.
2. Colica media.
3. Colica dextra.
4. Ileo-colica.
5. Inferior mesenteric a.
6. Colica sinistra.
7. Arteria sigmoidea.
8. Superior hæmorrhoidal a.

ANASTOMOSIS OF THE MESENTERIC ARTERIES.

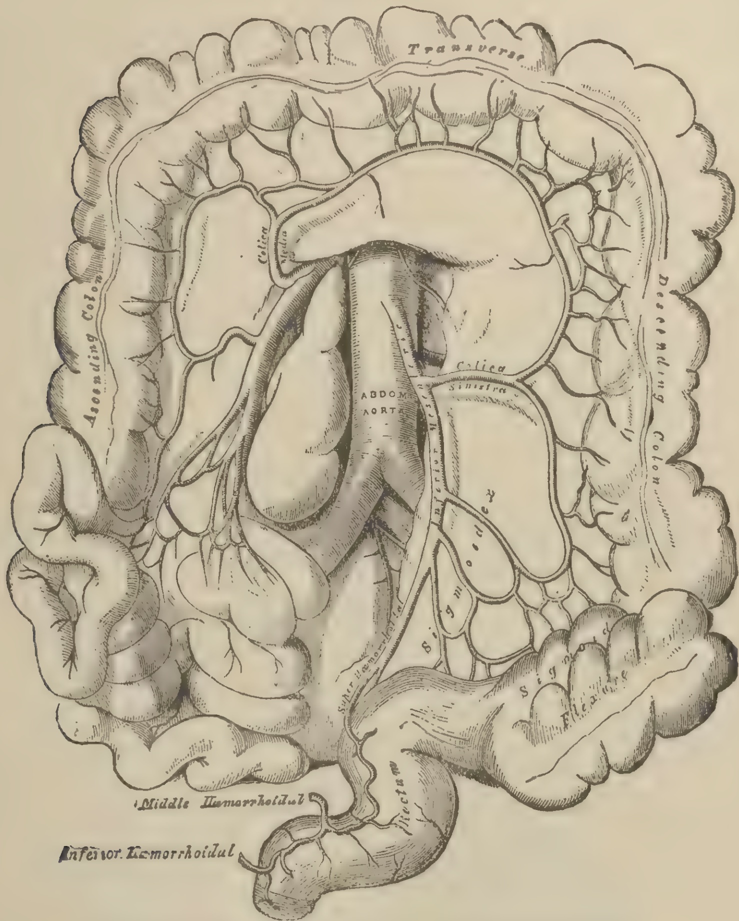
There are two other hemorrhoid arteries (middle and inferior hemorrhoidal), one of which is a branch of the internal iliac, and the other (inferior) of the internal pudic, which is itself a branch of the internal iliac.

The **supra-renal arteries** are two small vessels that supply the supra-renal capsules. They arise, one from each side of the aorta, opposite the superior mesenteric artery.

The **renal** (kidney) **arteries** are two large trunks which arise from the sides of the aorta, just below the supra-renal arteries. The right renal is longer than the left, on account of the position of the aorta on the left of the median line, and somewhat lower, corresponding to the position of the right kidney, which is depressed by the position of the liver. Previously to entering the kidney, each artery divides into four or five branches.

The **spermatic arteries** supply the testes of the male, and correspond to the ovarian of the female. These are two slender vessels which arise from the front of the aorta, a little below the renal arteries. They pass obliquely outward and downward through the inguinal canal, along the spermatic cord, to the testes in the scrotum. The *ovarian*

Fig. 144.



INFERIOR MESENTERIC ARTERY, AND ITS BRANCHES.

arteries are shorter than the spermatic, and do not pass out of the abdominal cavity, although some branches are continued along the round ligament to the labia. They supply the ovaries and oviducts.

The **lumbar arteries** are analogous to the intercostal. They arise, four in number, on each side, from the back part of the aorta, pass outward and backward around the sides of the body of the corresponding

vertebra, and divide each into two branches (dorsal and abdominal). The dorsal branch of the lumbar gives off a branch that enters the spinal canal (a spinal branch), and also supplies the muscles and integument of the back. The abdominal branches pass outward behind the square muscle of the loins (quadratus lumborum) to the abdominal muscles, and inosculate with branches of the epigastric, internal mammary, and others.

The **sacra media** (middle sacral) artery arises from the back part of the aorta, near its bifurcation, passes in front of the last lumbar vertebra and sacrum, supplies the posterior surface of the rectum, and inosculates with the two lateral sacral, which are branches of the internal iliac.

The **common iliac arteries** are the terminal branches of the aorta. The bifurcation (division of a trunk into two branches) takes place in the umbilical region on a level with the crest of the ilium (usually opposite the left side of the fourth lumbar vertebra). The common iliac arteries extend from the bifurcation of the aorta to the brim of the pelvis, and there bifurcate, forming the internal and external iliac arteries — one supplying the pelvic viscera, the other the lower extremity of the body. The common iliac arteries vary in length from one to eleven centimeters (one half to four and one-half inches). They are sometimes called "*primary* iliacs." They give off some small branches to the peritoneum, psoas muscles, and ureters, but none yet honored with a name.

Having completed the description of the aorta and its *primal* branches, we shall next describe some of the more important arteries that arise from these branches, commencing with the branches of those last described (the common iliacs).

The **internal iliac artery** (one of the two branches of the common iliac, on either side) supplies the walls and viscera of the pelvis, the genital organs, and the inner side of the thigh. It extends from the bifurcation of the common iliac artery, usually, to the upper margin of the great sacro-sciatic foramen, where it divides into two large trunks (anterior and posterior).

A partially obliterated cord (the *superior vesical* artery), which is the part of the fœtal hypogastric artery that does not become entirely obliterated after birth, extends from the internal iliac artery to the side and body of the bladder, and gives off a slender vessel that accompanies the vas deferens ("outward bearing vessel," applied to the seminal duct that forms a part of the spermatic cord) to the testis, and inosculates with the spermatic artery from the aorta.

The "middle vesical" of authors is a branch of the superior vesical artery.

The inferior vesical ("vesica," bladder) artery is a branch of the internal iliac, and is distributed to the bladder, prostate gland, and seminal vesicles (vesiculæ seminales). Besides the vesical arteries, the "anterior trunk" of the internal iliac gives off four other branches in the male, and six in the female. The six branches are the middle hemorrhoidal, obturator, internal pudic, sciatic, vaginal, and uterine. The last two are peculiar to the female. The sciatic and internal pudic are the terminal end) branches of the "anterior trunk."

The posterior trunk forms three branches,—the gluteal (which is the continuation of the posterior trunk), ilio lumbar, and lateral sacral. Altogether, the two trunks of the internal iliac artery have nine branches in the male, and eleven in the female. These branches are next described. The **middle hemorrhoidal artery** supplies a portion of the rectum, anastomosing (or inosculating) with the other hemorrhoidal arteries (superior and inferior hemorrhoidal). The **obturator artery** passes out of the pelvis through the upper part of the obturator ("closed up," but not entirely) foramen, and divides into an internal and external branch, and supplies with blood various muscles of the thigh. Within the pelvis the obturator artery gives off an iliac branch to the iliac muscle, a vesical branch to the bladder, and a pubic branch, which ascends upon the back, or inner side, of the pubes, and communicates with branches of the epigastric. The pubic branch of the obturator is placed on the inner side of the femoral ring. The **internal pudic artery** supplies the external organs of generation. Its terminal branches in the male are the dorsal artery of the penis, and the artery of the corpus cavernosum ("spongy body," or body filled with cavities). In the female the two terminal branches supply the clitoris.

In the perineum (floor of the pelvis) the internal pudic gives off, in addition to those already mentioned, four other branches (artery of the bulb, which supplies the bulb of the urethra and Cowper's gland; inferior hemorrhoidal, which supplies muscles and integument of the anal region; and two perineal—superficial and transverse). The artery of the bulb is very liable to be severed in the lateral operation of lithotomy ("cutting for stone" in the bladder). When severed it gives rise to alarming hemorrhage (bleeding).

The **sciatic artery** distributes blood to muscles on the back of the pelvis. It escapes from the pelvis through the great sacro-sciatic foramen, between the pyriform and coccygeus muscles. Within the pelvis it supplies branches to the muscles just named, to the rectum, neck of the bladder, and prostate gland. External to the pelvis it gives off five branches; viz., the coccygeal, to the back of the coccyx, the infe-

rior gluteal, the comes nervi ischiatici (companion of the sciatic nerve), the muscular, and the articular. The latter supplies the capsule of the hip joint. The companion of the sciatic nerve accompanies the nerve for a short distance, then *penetrates* it, and runs in its substance to the lower part of the thigh.

The vaginal artery supplies the mucous membrane of the vagina, and some branches to the neck of the bladder.

The uterine artery, together with the ovarian from the aorta, supplies the uterus. The *gluteal artery* is the largest branch of the internal iliac, but soon divides into a superficial and deep branch. It supplies muscles in and about the pelvis and hip joint.

The *ilio-lumbar artery* ascends to the upper part of the iliac fossa, and divides into two branches (lumbar and iliac). The *lateral sacral arteries* are usually two in number on each side,—superior and inferior. This completes the branches of the internal iliac.

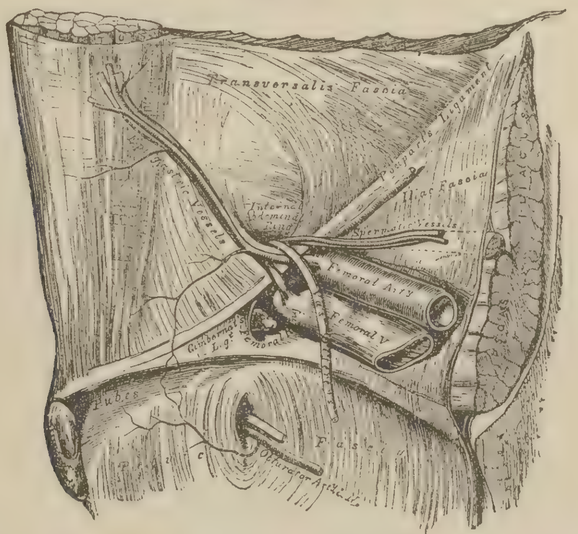
The **external iliac artery** is the chief vessel of supply to the lower limb. It extends from the common iliac artery obliquely downward and outward, along the inner border of the psoas muscle to Poupart's ligament (called also "femoral arch"), beneath which it passes to enter the thigh, where it becomes the femoral (thigh) artery. Its principal branches are the deep epigastric and the circumflex iliac. A knowledge of the *deep* epigastric (Gray calls this artery the "epigastric" simply, but there are two other epigastric arteries [the *superficial*, from the femoral artery, and the superior epigastric, from the internal mammary], and it is well to distinguish them) artery is important in operations for strangulated hernia.

The **deep epigastric** arises from the front of the external iliac near Poupart's ligament, and ascends in the wall of the abdomen between the peritoneum and transversalis fascia, or, we may say, between the peritoneum and abdominal muscles, obliquely upward and inward to the border of the rectus muscle near its lower third, then directly upward behind the muscle till it anastomoses with the branches of the internal mammary and intercostal arteries. As it ascends, it lies *behind* the inguinal canal to the inner side of the internal abdominal ring (upper orifice of the inguinal canal) and immediately *above* the femoral ring (upper opening of the femoral canal. The femoral canal is the narrow space between the femoral vein and the inner wall of the crural, or femoral sheath. "Crural" and "femoral" are used interchangeably). The deep epigastric artery varies in its point of origin, from several centimeters (one or two inches) above Poupart's ligament to some point below. It also varies in its mode of origin. It is accompanied by two veins, which usually unite before reaching the external iliac vein.

The circumflex iliac artery arises from the external iliac, near the origin of the deep epigastric, runs along the inner surface of the crest of the ilium to its middle part, where it pierces the inner muscle (transverse) of the abdomen, and supplies both it and the middle abdominal muscle (the internal oblique), and inosculates with the lumbar and epigastric arteries.

The **femoral artery** is the continuation of the external iliac (called *external* to distinguish it from the *internal* iliac: both are within the abdomen). The femoral artery extends from its origin beneath Poupart's ligament at its middle part, downward through the upper two

Fig. 145.

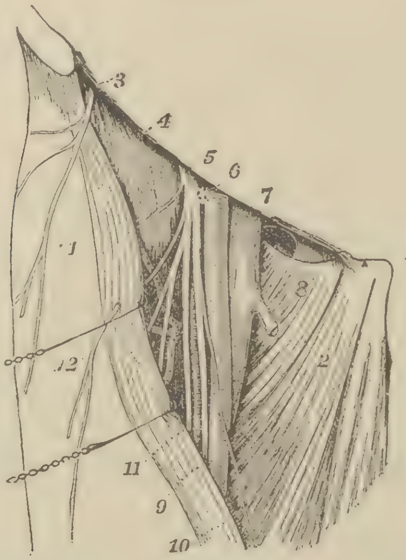


INTERNAL VIEW OF THE FEMORAL AND INTERNAL ABDOMINAL RINGS—RIGHT SIDE.

thirds of the thigh to the opening in the adductor magnus muscle, where it takes the name of the popliteal artery. Popliteal, femoral, and external iliac are the names of the three portions of the same vessel which extends from the common iliac within the abdomen to the tibial arteries, about five centimeters (two inches) below the knee-joint. At the upper part of the thigh, where the femoral artery emerges from beneath Poupart's ligament, this large vessel is very superficial, and is contained in a triangular space, called "Scarpa's triangle." Poupart's ligament forms the base, or upper border of this triangle, and the border of two muscles (sartorius and adductor longus) forms its sides. This triangle is divided into two nearly equal parts by the

femoral vessels (femoral artery and femoral vein), which extend from the middle of its base to its apex below. The femoral vein lies on the inner side of the artery, and the anterior crural nerve on the outer side, but separated by the psoas muscle from the artery; or, we may say, more briefly, that the femoral artery lies *between* the vein and nerve; or, again, between the vein and psoas magnus muscle. In this space (Scarpa's triangle) the femoral artery gives off its cutaneous and deep (the profunda femoris) branches, and the femoral vein receives the deep femoral (profunda femoris) and the internal saphenous vein. The femoral artery and vein are inclosed in the same sheath, but separated from each other b a thin, fibrous partition.

Fig. 146.



1. Sartorius.
2. Adductor longus.
3. External cutaneous n.
4. Iliacus internus.
5. Anterior crural n.
6. Femoral artery.

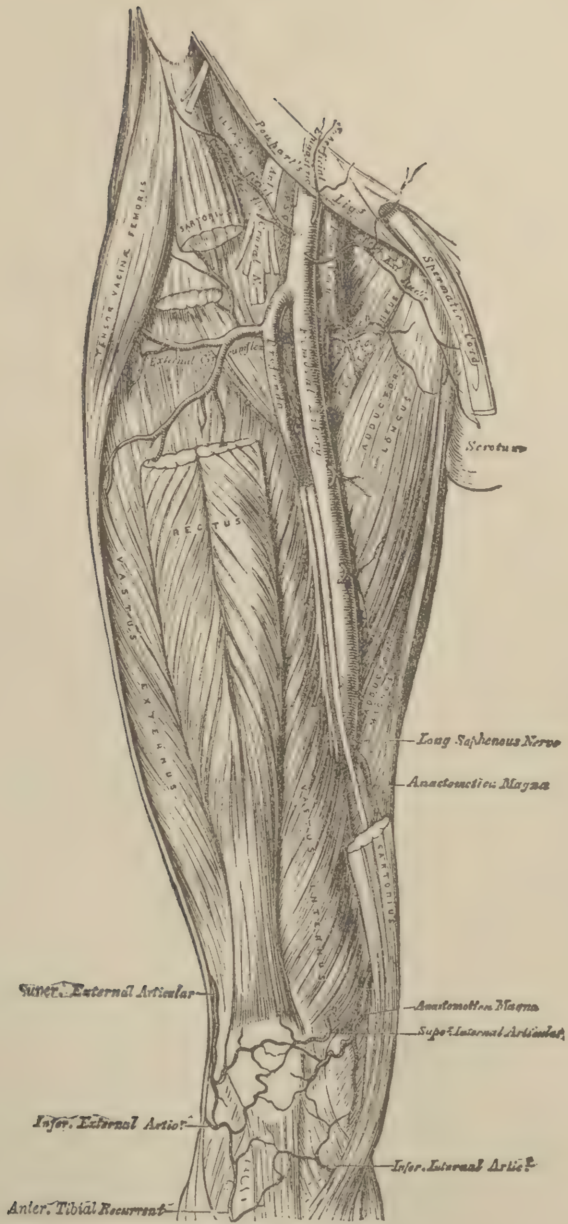
7. Femoral vein.
8. Pectineus.
9. Long saphenous n.
10. Internal cutaneous n.
11. Nerve to vastus internus.
12. Middle cutaneous n.

SCARPA'S TRIANGLE; ITS BORDERS AND CONTENTS.

The femoral artery, the popliteal, and the posterior tibial, give off, each, seven branches. In each upper extremity we also have three arteries (axillary, brachial, and ulnar), which give off, each, seven branches.

It should not be understood that these arteries never give off more than seven branches, but only seven *with anatomical names*. Sometimes a single name includes several branches; as, for instance, the "muscular," which is given as a branch of the femoral artery, is a common name for several vessels that supply chiefly the sartorius and vastus internus muscles. The other branches of the femoral artery are the anastomotica magna (great anastomosing artery); the profunda

Fig. 147.



THE FEMORAL ARTERY.

("deep"); the superficial, and the deep external pudic; the superficial circumflex iliac; and the superficial epigastric. The **profunda femoris** (deep femoral) is nearly as large as the vessel (femoral artery proper, or superficial femoral) from which it springs. It arises from the outer and back part of the femoral artery, three or four centimeters (about an inch and a half) below Poupart's ligament, and supplies the muscles of the thigh.

The **popliteal artery** lies in the popliteal space. The popliteal ("poples," ham) space is a lozenge-shaped space at the back of the knee. It is bounded above by the hamstring muscles (the biceps on the outer side, and the semimembranosus, semitendinosus, gracilis, and sartorius on the inner), and below by the two heads (inner and outer) of the gastrocnemius. The space is covered over by the fascia lata and by the common integument. The floor of the popliteal space is formed by the posterior surfaces of the femur and tibia near the knee, the posterior ligament of the knee (called also ligament of Winslow), and the popliteus m uscle which passes obliquely across the upper part of the tibia, downward and inward behind the knee. This space contains the popliteal blood-vessels, popliteal nerves, the small sciatic nerve, and the termination of the external saphenous vein. (The internal, or long saphenous vein ascends to the groin, and terminates in the femoral vein, a little below Poupart's ligament).

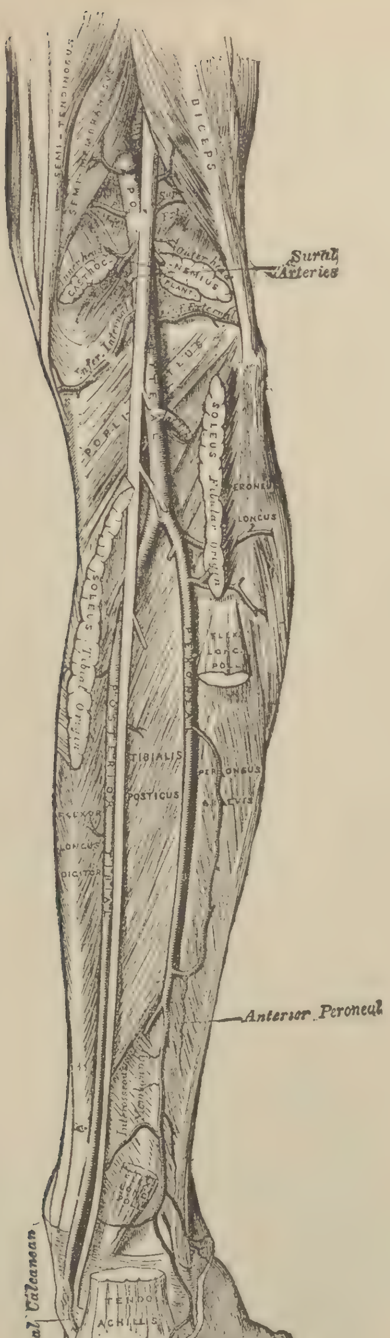
The popliteal lymphatic glands also lie in the popliteal space, and when enlarged by disease simulate aneurism (arterial pulsating tumor), pulsation being communicated to them from the popliteal artery.

The popliteal artery lies deeply in the popliteal space, close to the bone; and passing off from it, at right angles, are its articular (joint) branches, five in number, and designated as internal and external superior, internal and external inferior, and azygos. The two remaining branches of the popliteal artery are the muscular and the cutaneous. There are four or five of the muscular branches. The azygos articular pierces the posterior ligament of the knee, and supplies the ligaments and synovial membrane in the interior of the joint.

The popliteal artery is that part of the main vessel of the lower extremity which lies between the opening in the adductor magnus muscle above, and the bifurcation of the vessel at the lower border of the popliteus muscle, where it forms the anterior and posterior tibial arteries.

The **anterior tibial** passes through an opening in the interosseous membrane (membrane which connects the contiguous borders of the tibia and fibula), and extends down the front of the leg to the ankle-joint, and becomes the dorsalis pedis ("back," or upper side "of the

Fig. 148.



THE POPLITEAL, POSTERIOR TIBIAL, AND PERONEAL ARTERIES.

foot"). The posterior tibial artery extends down to the vicinity of the internal malleolus, and divides into the *two plantar arteries*, which supply the sole of the foot.

The branches of the anterior tibial, are the recurrent tibial (so called, because it runs upward from its origin to the knee), the muscular (several branches), and the internal and external malleolar arteries. The latter supply the ankle joint.

The seven branches of the posterior tibial artery, are the peroneal (or fibular), muscular, nutrient, communicating, internal calcanean, and internal and external plantar.

Fig. 149.

THE PLANTAR ARTERIES — DEEP VIEW.

The peroneal artery descends along the inner border of the fibula (peronē) to the back of the ankle, to inosculate with the external malleolar and external plantar arteries.

The muscular branches supply the soleus and deep muscles at the back of the leg.

The nutrient artery of the tibia is the largest nutrient artery (artery entering the bone) in the body. It enters the tibia obliquely from above downward (its course is directed *away from the knee*, as is also the nutrient artery of the femur).

The communicating artery runs across the back of the tibia, near its lower end.

The internal calcanean supplies parts about the heel.

The plantar supply the sole of the foot.

The external plantar has two sets of branches — the digital and posterior perforating.

Having described the arteries of the lower extremities, we shall now return to that branch of the aorta which supplies blood to the right upper extremity and right side of the head — the **innominate artery.**

Behind the inner (or sternal) end of the right clavicle, where it joins the sternum, the innominate artery divides into the right subclavian (under the clavicle) and right common carotid.

The **right subclavian** supplies the right upper extremity, and extends to the outer border of the first rib, where, entering the axilla (armpit), it is called the axillary artery, and again receives a new name (brachial), opposite the surgical neck of the humerus, where it leaves the axillary space. The same vessel continues its course to the bend of the elbow, where it bifurcates, and forms the radial and ulnar arteries. Each part (subclavian, axillary, and brachial arteries) of the vessel, which, as a whole, extends from the sternum throughout the armpit to the elbow, is described separately; and, further, the subclavian itself is divided into three portions by the inner and outer borders of the anterior scalene (scalenus anticus) muscle, behind which it passes. The first portion of the subclavian extends to the inner border of this muscle; the second portion lies behind the muscle; and the third portion extends from the outer border of this muscle to the end of the subclavian, at the outer border of the first rib, where it receives the name of axillary artery.

Arising from the innominate instead of the arch of the aorta, like its fellow on the left, the first portion of the right subclavian differs from the first portion of the left subclavian in length, direction, and in the structures to which it bears relation. It is shorter than the same portion of the left by the whole length of the innominate, and arches upward and outward, while the left ascends almost vertically upward. It ascends slightly above the clavicle, and is covered in front by the integument, platysma myoid, the clavicular origin of the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, and is crossed by the vertebral and internal jugular veins, and by the pneumogastric (lung and stomach), cardiac (heart), and phrenic (diaphragm) nerves.

The first portion of the left subclavian artery is situated more deeply in the cavity of the chest; has the pleura and left lung in front and upon its outer side, the trachea (windpipe) upon its inner side, and the œsophagus and thoracic duct, both behind and upon the inner side. The

second and third portions of the subclavian arteries are precisely similar on both sides, so that one description answers for both, as in most parts of the two sides of the body.

The second portion of each subclavian is short, and lies behind the anterior scalene muscle, or between it and the middle scalene muscle. It forms the highest part of the arch described by the subclavian artery. The subclavian (under or behind the clavicle) vein lies below and in front of the artery.

Fig. 150.

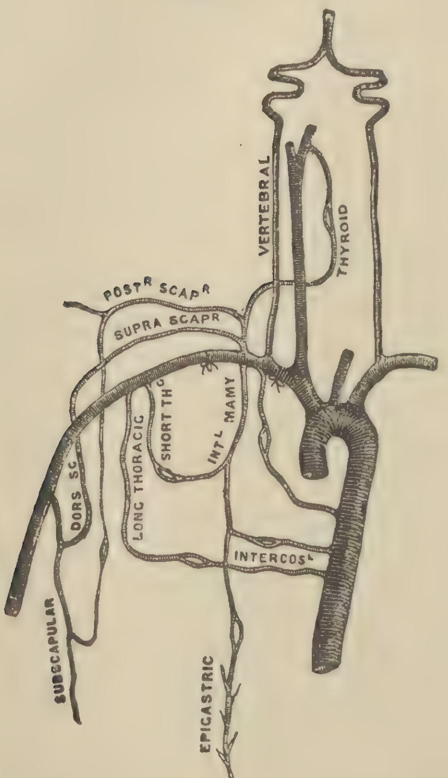
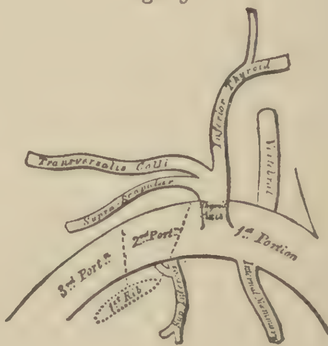


Fig. 151.



THE SUBCLAVIAN ARTERY; ITS PORTIONS, BRANCHES, AND ANASTOMOSES.

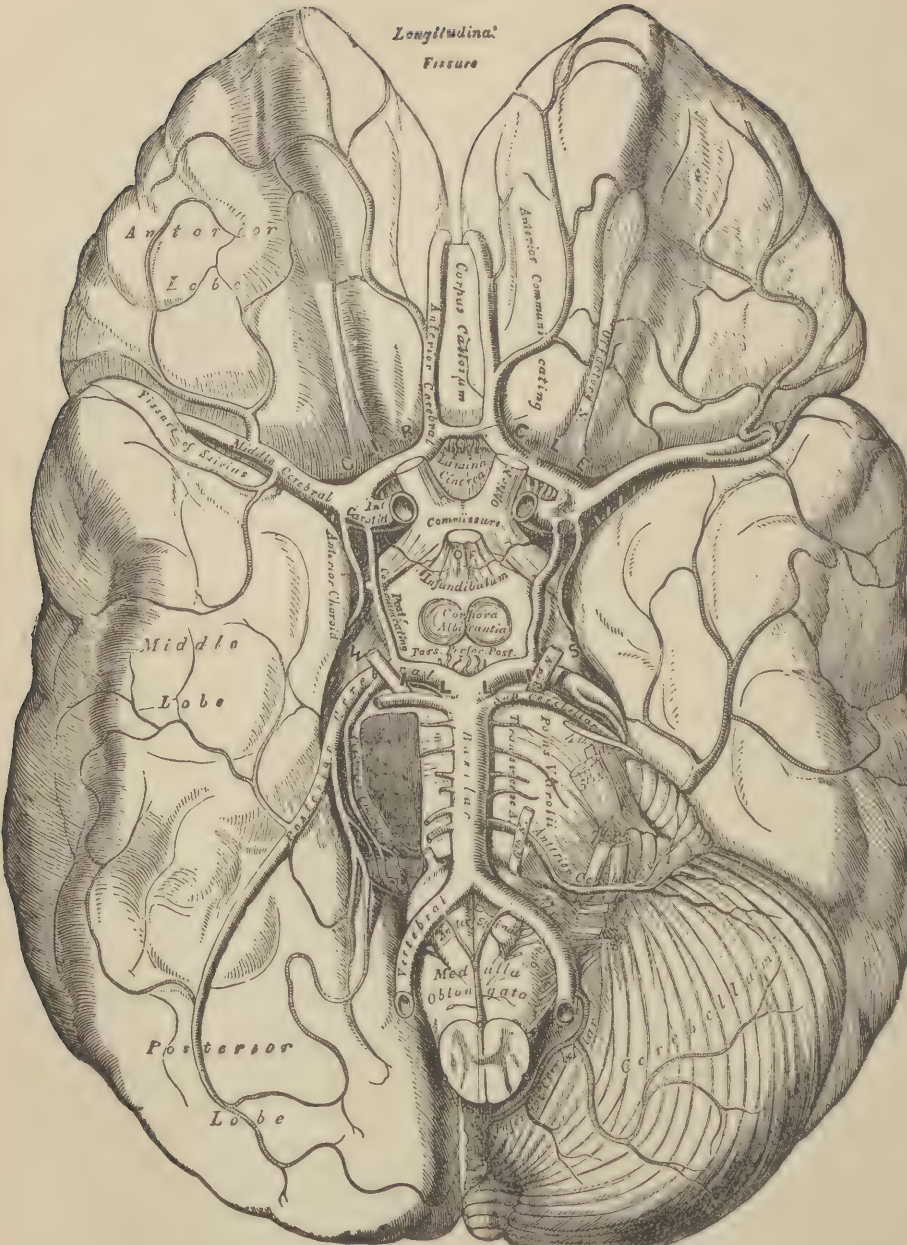
The third portion of the subclavian artery is the most superficial, and is contained in a triangular space (the subclavian triangle) formed by the clavicle below and by the borders of the omo-hyoid and sterno-mastoid muscles above. The brachial plexus of nerves lies above, and in close contact with the artery.

The subclavian gives off four branches,—the vertebral, internal

mammary, thyroid axis, and superior intercostal. The other intercostals are given off from the aorta and internal mammary. Of the four branches given off by the subclavian, one (the superior intercostal) usually arises from the second portion of the vessel, the rest from the first portion. The vertebral arises from the upper and back part of the first portion; the internal mammary from the under part; the thyroid axis, like the cœliac axis of the aorta, from the front part, and the superior intercostal from the lower and back part, either of the first or second portion.

The **vertebral artery**, on either side of the neck, ascends through a foramen (the transverse) in the transverse process of each cervical vertebra, except the last (seventh), enters the cranium through the foramen magnum of the occipital bone, runs along the basilar groove in front of the medulla oblongata to the lower border of the pons Varolii (bridge of Varolius), and unites with its fellow of the opposite side to form the **basilar artery.** The latter extends from the posterior to the anterior border of the pons Varolii, gives off branches to the cerebellum, and divides into the two *posterior cerebral arteries.* These (the posterior cerebral) supply the posterior lobes of the cerebrum (upper brain), and inosculate with the middle and anterior cerebral arteries, which are branches of the internal carotid. In the neck, the vertebral artery gives off a branch (the *lateral spinal*) to the spinal canal, and *muscular* branches to the deep muscles; in the cranium it gives off four branches,—the *posterior meningeal*, which ramifies between the occipital bone and the meninges (membranes, or coverings of the brain), and also supplies the falx cerebelli; the *anterior spinal*, which descends on the front of the spinal cord, and unites with various other spinal branches, from the intercostal, lumbar, and sacral arteries, to form the anterior median; the *posterior spinal*, which descends along the back part of the spinal cord, and the *inferior cerebellar*, which extends to the under surface of the cerebellum (lower, or back brain). The anterior median artery extends along the anterior median fissure of the spinal cord, and sends branches to the cauda equina (nerve filaments from the lower part of the cord). The basilar artery (named from its position at the base of the skull), formed by the union of the two vertebral arteries, may properly be called an azygos artery, because it is single (lying in the median line of the body), while most of the arteries, bones, muscles, veins, and nerves are in pairs. It gives off four sets of branches (transverse, anterior cerebellar, superior cerebellar, and posterior cerebral). The cerebellar relate to the back brain, and the cerebral to the upper or front brain. The posterior cerebral are the terminal branches, and help to form the remarkable

Fig. 152.



ARTERIES AT THE BASE OF THE BRAIN.

anastomosis (circle of Willis) between the branches of the great arteries of the brain (internal carotid and vertebral.)

The **circle of Willis** is formed, in front, by the two "anterior cerebral" and the "anterior communicating" (the latter connects the two anterior cerebral); at the sides chiefly, by the "posterior communicating" (one on each side, connecting the internal carotid with the posterior cerebral); and behind by the two posterior cerebral arteries, which are the terminal branches of the basilar; or, more briefly, this circle, or anastomosis, is formed by the anterior and posterior cerebral, and anterior and posterior communicating arteries. The internal carotid arteries (by the length of their diameters) assist in forming the circle of Willis. By this anastomosis of the great arteries of the brain, the circulation is equalized, and provision made for its continuance so long as the basilar (formed by union of the two vertebral arteries), or either carotid is unobstructed.

The **internal mammary artery** arises from the subclavian (near the origin of the thyroid axis), descends behind the clavicle and costal (rib) cartilages near the side of the sternum (breastbone), and at the interval between the sixth and seventh cartilages divides into the musculo-phrenic (muscles and diaphragm) and superior epigastric arteries. Besides the terminal, the internal mammary gives off six other branches or sets of vessels: the superior phrenic (or comes nervi phrenici,—companion of the phrenic nerve), mediastinal, pericardiac, sternal, anterior intercostal, and perforating.

The **superior phrenic** artery accompanies the phrenic nerve to the diaphragm.

The **mediastinal** branches supply parts of the space between the lungs (the mediastinum).

The **pericardiac** and **sternal** branches supply the upper part of the heart-case (pericardium) and both surfaces of the sternum (breastbone).

The **anterior intercostal** (between the ribs) inosculate with the intercostals from the aorta, and supply the intercostal and pectoral (breast) muscles, and also the mammary gland.

The **perforating** arteries are also distributed to the mammary gland and greater pectoral muscle. During lactation these vessels are of large size.

The **musculo-phrenic** feeds the diaphragm, and extends to the abdominal muscles.

The **superior epigastric** descends to the rectus muscle of the abdomen, and inosculates with the deep epigastric from the external iliac.

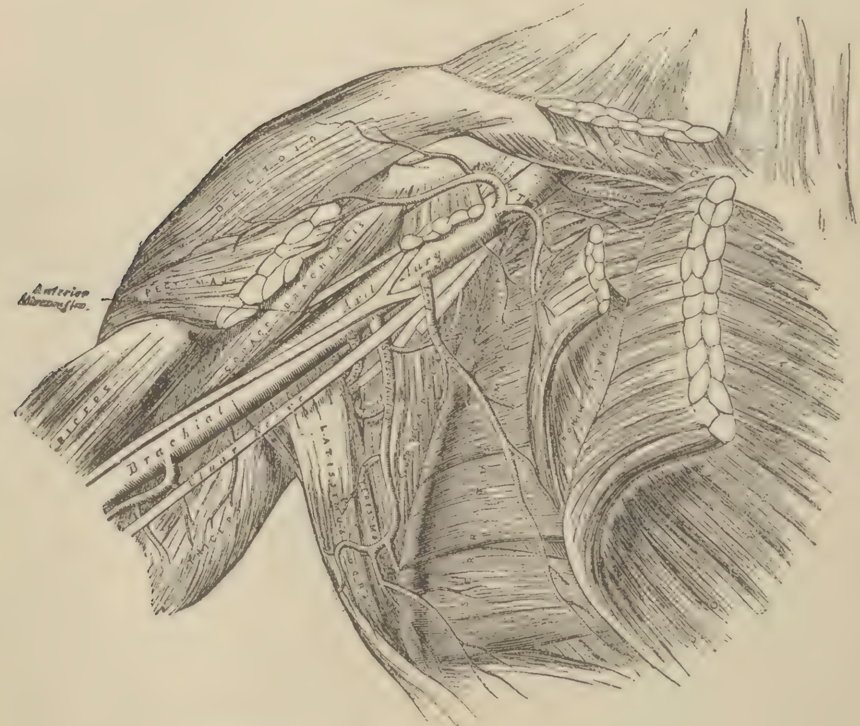
The **thyroid axis** is a short trunk arising from the front of the sub-

clavian artery, and dividing almost immediately into three branches,—the inferior thyroid, the suprascapular, and the transversalis colli.

The **inferior thyroid** ascends to the under surface of the thryoid gland, and gives branches to the larynx (organ of voice), trachea (windpipe), œsophagus, and other parts of the neck.

The **suprascapular artery** passes outward, across the root of the neck, to the upper border of the scapula (shoulder blade), over the transverse ligament to the supra-spinous muscle, and some other parts.

Fig. 153.



THE AXILLARY ARTERY AND ITS BRANCHES.

The **transversalis colli** (transverse of the neck) passes transversely outward, across the upper part of the subclavian triangle, to the anterior border of the trapezius muscle.

The **superior intercostal artery** is the fourth and last branch of the subclavian. It runs downward, like the internal mammary, and inosculates with the first aortic intercostal.

The **axillary artery** (in the armpit, or axillary space) is the continuation of the subclavian. It extends to the surgical neck of the humerus,

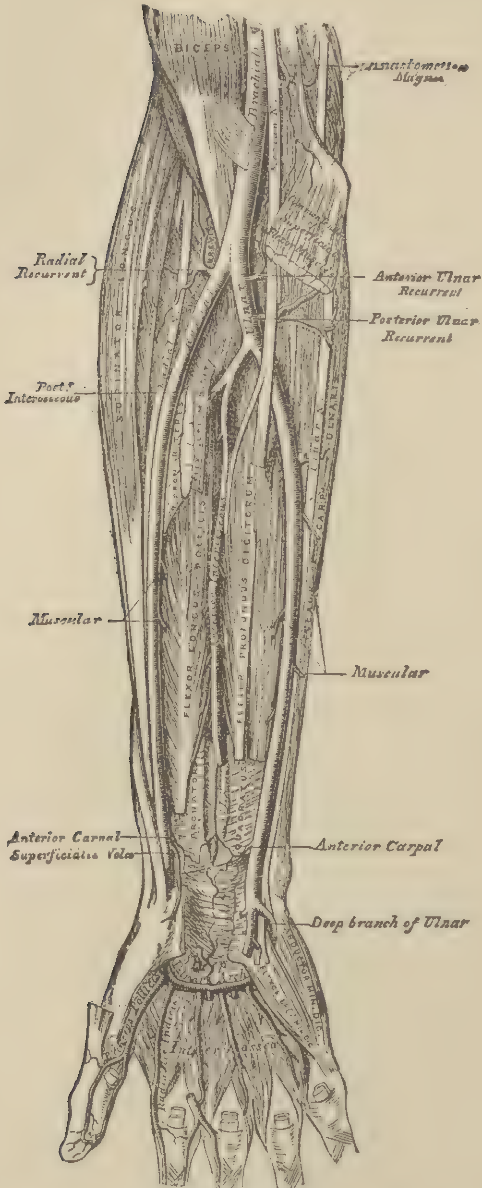
where it becomes the brachial. Its branches are the superior thoracic, acromial thoracic, thoracica longa (long thoracic), alar thoracica (a small branch), subscapular, anterior, and posterior circumflex. The circumflex arteries wind around the neck of the humerus. The branches of the axillary artery are distributed chiefly to the muscles of the breast, side, and arm. The thoracica longa supplies in part the mammary gland.

The **brachial artery** extends from the neck of the humerus to the bend of the elbow, or a little below, where it divides, and forms the radial

Fig. 154.

THE BRACHIAL ARTERY.

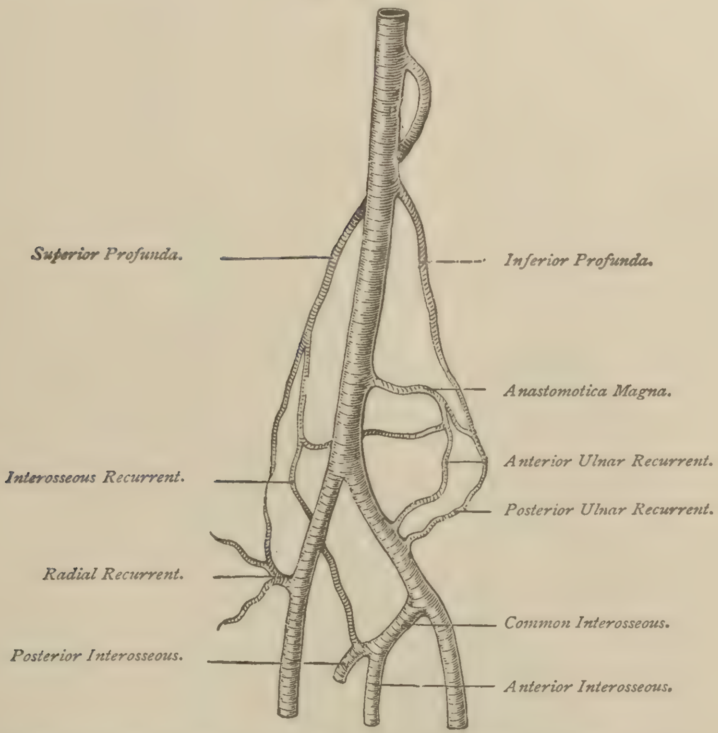
Fig. 155.



ULNAR AND RADIAL ARTERIES — DEEP VIEW.

and ulnar arteries. It is superficial throughout its entire extent. At its middle part the median nerve lies upon it. It is accompanied by two veins — the venæ comites of the brachial artery, which lie in close contact with it. These vessels lie along the inner border of the biceps muscle. Compression of the artery (in case of wounds) may be effected in almost any part of its course. Near the elbow it lies in front of the bone, but above, at its inner side. The brachial artery of Chaussier includes the brachial, axillary, and subclavian of other authors. The seven

Fig. 156.



BRACHIAL ARTERY, WITH ITS BRANCHES AND INOSCULATIONS ABOUT THE RIGHT ELBOW.

branches of the brachial artery are the superior profunda, the nutrient, inferior profunda, anastomotica magna (another of the same name is found in the thigh), muscular, radial, and ulnar. The nutrient artery supplies the shaft of the humerus.

In the upper extremity, the nutrient arteries enter the bones obliquely toward the elbow; in the lower extremity, in a direction upward and downward *from* the knee. The nutrient arteries are sometimes called medullary arteries.

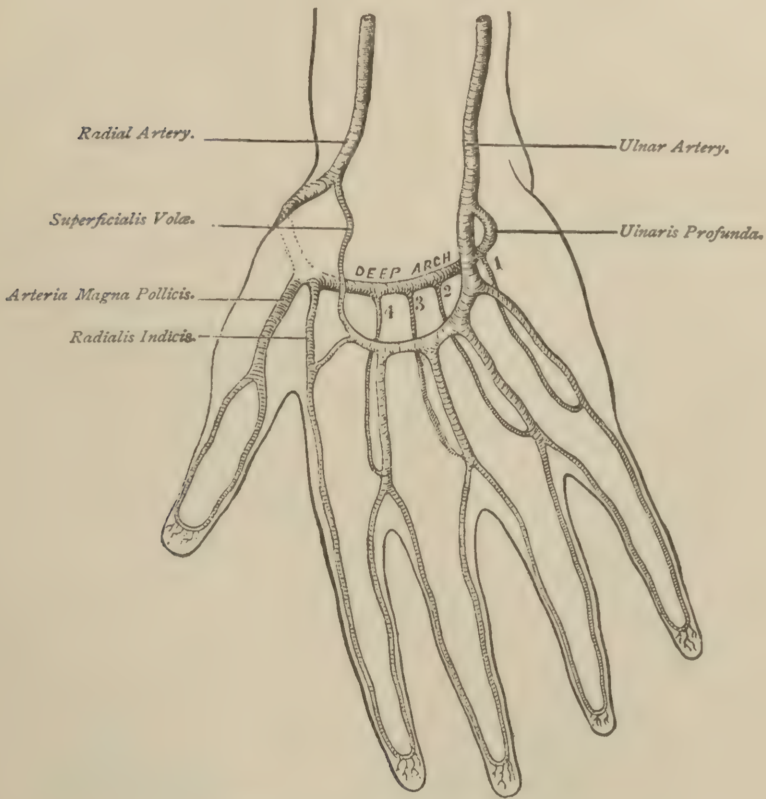
Fig. 157.

RADIAL AND ULNAR ARTERIES.

The **superior profunda artery** is accompanied by the musculo-spiral nerve; and the *inferior profunda*, by the ulnar nerve. Both descend to the elbow, and supply muscles of the arm with blood. The anastomotica magna (great anastomosing) is so named on account of its junction with several other vessels near the elbow. The muscular (usually three or four branches) supply muscles of the arm.

The **radial artery** is, *in direction*, the continuation of the brachial, but is not so large as the *ulnar* branch of the brachial. It commences

Fig. 158.



SUPERFICIAL AND DEEP PALMAR ARCHES.

1, 2, 3, 4, Digital Branches.

at the bifurcation of the brachial just below the elbow, and runs along the radial side (side above the thumb) of the forearm to the wrist, and *may be felt*, by its pulsations, just outside the tendon of the flexor carpi radialis muscle. The radial nerve lies along the outer side of the artery in the middle third of its course, and two veins (venæ comites) attend it throughout its whole extent. In the hand, the radial artery inoscu-

lates with a communicating branch from the ulnar artery, and forms the **deep palmar arch.** The branches of the radial, *as usually given*, are twelve in number, divided equally among the forearm, wrist, and hand. Those of the forearm are the radial recurrent, muscular, superficialis volæ, and anterior carpal. The radial recurrent is given off near the origin of the radial, and runs upward to the elbow. The muscular branches are distributed to the muscles on the radial side of the forearm. The superficialis volæ (superficial of the hollow of the hand) supplies muscles of the thumb, and assists in forming the **superficial palmar arch.** The anterior carpal supplies in part the wrist joint. The posterior carpal is one of the wrist group, but those of the wrist and hand are comparatively unimportant. Really, the radial artery has in all about *eighteen* branches.

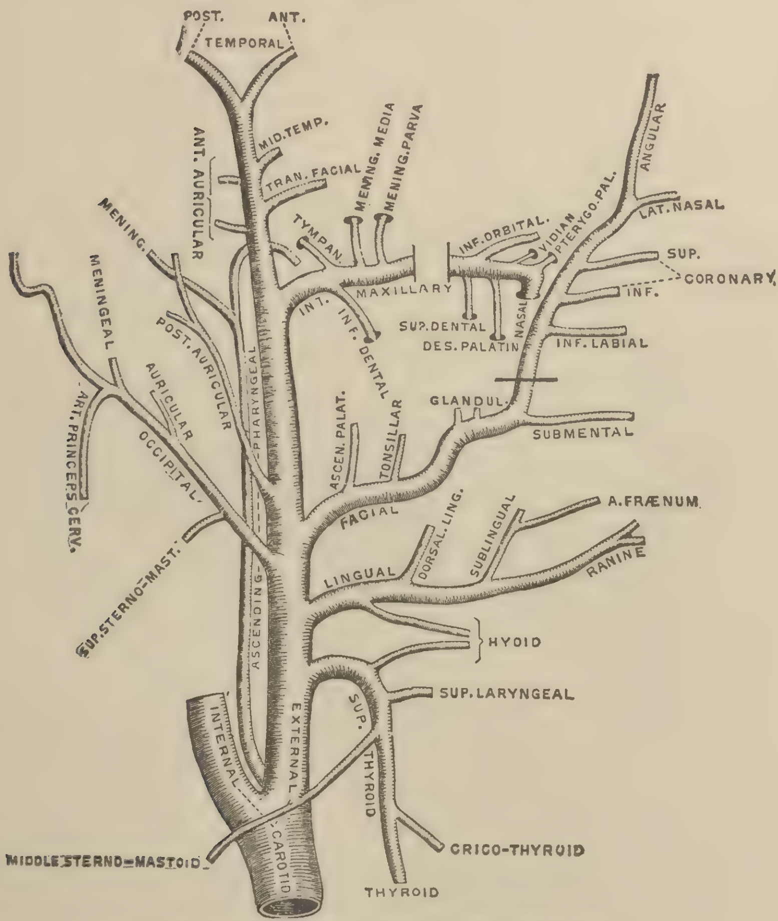
The **ulnar artery** crosses obliquely the inner side of the forearm to its middle, then runs along its ulnar border (the side above the little finger) to the wrist, crosses the annular ligament, and curving across the palm toward the ball of the thumb, forms the **superficial palmar arch,** by inosculating with a branch (the superficialis volæ) of the radial artery. The seven branches of the ulnar are the anterior and posterior ulnar recurrent; the anterior and posterior carpal; the interosseous; the deep, or communicating; and the digital. The *digital branches* are *four* in number, and are given off from the convexity of the deep palmar arch. Gray mentions, also, muscular branches for the muscles of the ulnar side of the forearm.

We have now named and described the principal branches of the aorta, and also the arteries of the upper and lower extremities. There remain to be described the external and internal carotid arteries and their principal branches. The carotid arteries, one on each side, carry blood to the head; the internal supplying parts mostly *within* the cranium, and the external parts *without*. The word "carotid" is of Greek origin, and is nearly equivalent in signification to the word "narcotic." It signifies something that stupefies. Some other word, might, perhaps, be more appropriate; but we accept it because so well established, and may be reminded that *impure* blood flowing through these arteries stupefies the mind.

The **external carotid artery** extends from the bifurcation of the common carotid at the upper border of the thyroid cartilage (Adam's apple) to a point just behind the neck of the condyle of the lower jaw, where it divides into the temporal and internal maxillary arteries. Besides these terminal branches, the external carotid gives off six other branches, in order, from below, upward, as follows: ascending pharyngeal, superior thyroid, lingual, occipital, facial, and posterior

auricular. The superior thyroid, lingual, and facial are given off anteriorly, the ascending pharyngeal, occipital, and posterior auricular posteriorly. The superior thyroid occasionally arises from the common carotid, but usually the common carotid has only its terminal branches. The average length of the external carotid is about eight centimeters (three inches). It is contained in the superior carotid

Fig. 159.



EXTERNAL CAROTID ARTERY AND BRANCHES.

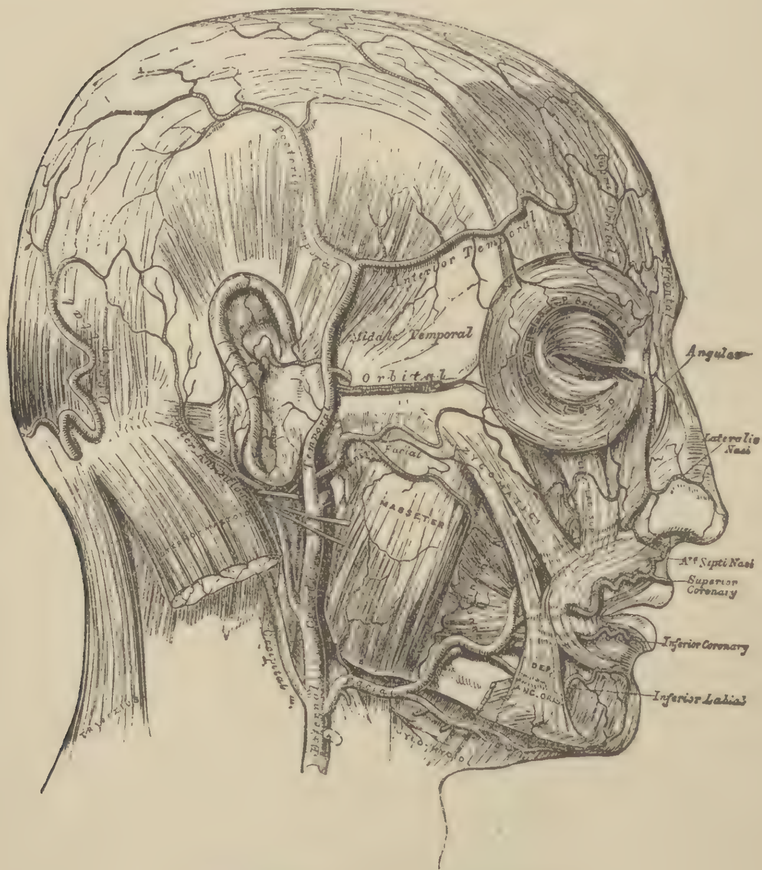
triangle. Of the two terminal branches, the internal maxillary is the larger. The other large branches of the external carotid are those given off anteriorly; viz., the facial, lingual, and **superior thyroid.** The latter supplies the upper part of the thyroid gland, and also the sterno-cleido-mastoid, and hyoid muscles, and parts of the larynx. It

inosculates with its fellow of the opposite side and with the inferior thyroid from the thyroid axis of the subclavian.

The lingual artery supplies the tongue, and at its tip, on the under side, becomes the ranine.

The facial artery passes upward and forward to the submaxillary gland, in which it lies imbeded, crosses the body of the lower jaw,

Fig. 160.



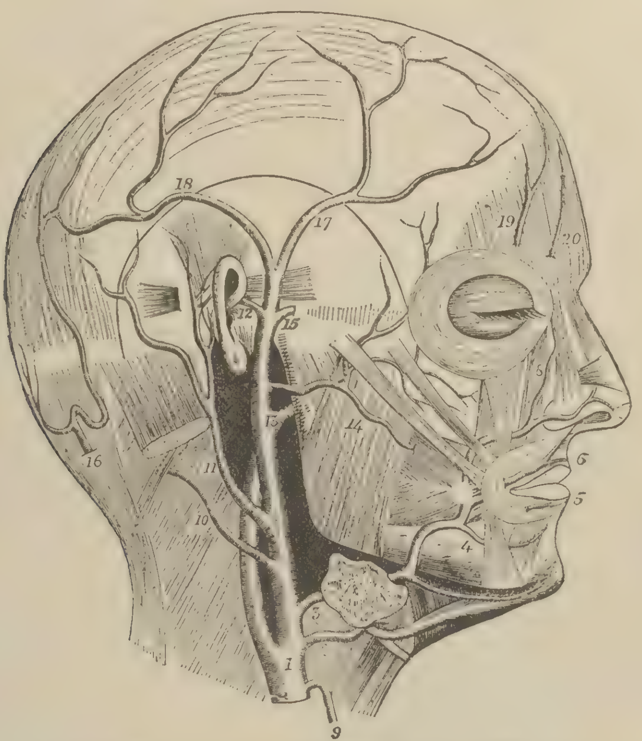
ARTERIES OF THE FACE AND SCALP.

where it is easily compressed, ascends across the cheek to the angle of the mouth, then passes upward along the side of the nose to terminate at the inner canthus (angle) of the eye under the name of the *angular artery*. The latter passes along the inner border of the orbit. The facial artery gives off ten (branches and sets of) branches to the lips, tonsil, nose, etc., and anastomoses with six. Through the ophthalmic

branch of the internal carotid the facial artery serves to connect the internal with the external carotid. The superior and inferior coronary arteries are branches of the facial. The latter run to the lips.

The **occipital artery** arises from the external carotid opposite the facial, ascends obliquely upward and backward behind the mastoid process of the temporal bone to the back part of the occipital bone, which it ascends in a tortuous course toward the vertex of the head.

Fig. 161.



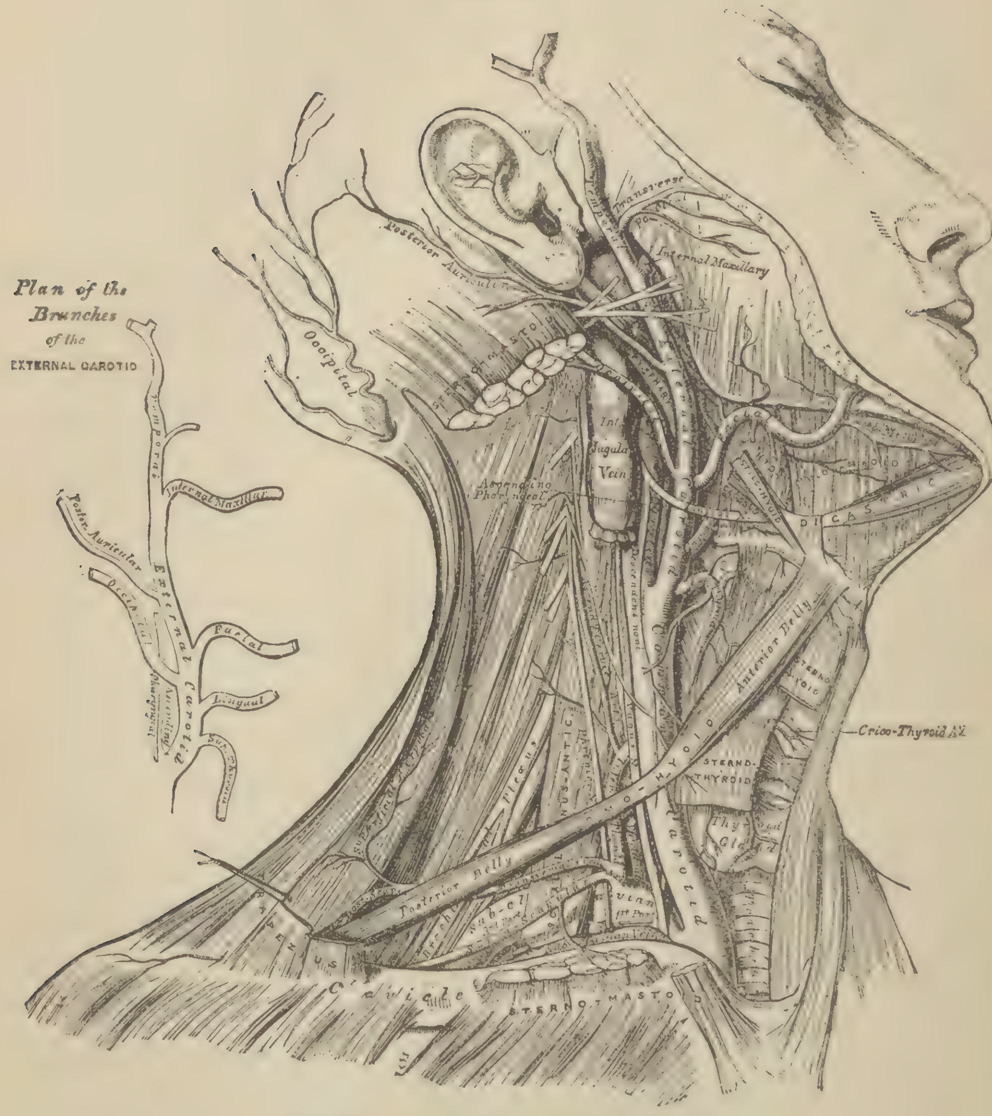
BRANCHES OF THE EXTERNAL CAROTID ARTERY.

1. External Carotid.
2. Lingual.
3. Facial.
4. Inferior Labial.
5. Inferior Coronary.
6. Superior Coronary.
7. Lateral Nasal.
8. Angular.
9. Superior Thyroid.
10 and 16. Occipital.
11. Posterior Auricular.
12. Anterior Auricular.
13. Internal Maxillary.
14. Transverse Facial.
15. Middle Temporal.
17. Anterior Temporal.
18. Posterior Temporal.
19. Supraorbital.
20. Frontal.

The **posterior auricular** artery runs obliquely upward and backward behind the ear, dividing into the *stylo-mastoid* and the *auricular*.

The **ascending pharyngeal artery** is the smallest branch of the external carotid. It is a long, slender vessel extending from its origin in the lower part of the external carotid almost directly upward to the

Fig. 162.



EXTERNAL AND COMMON CAROTID ARTERIES.

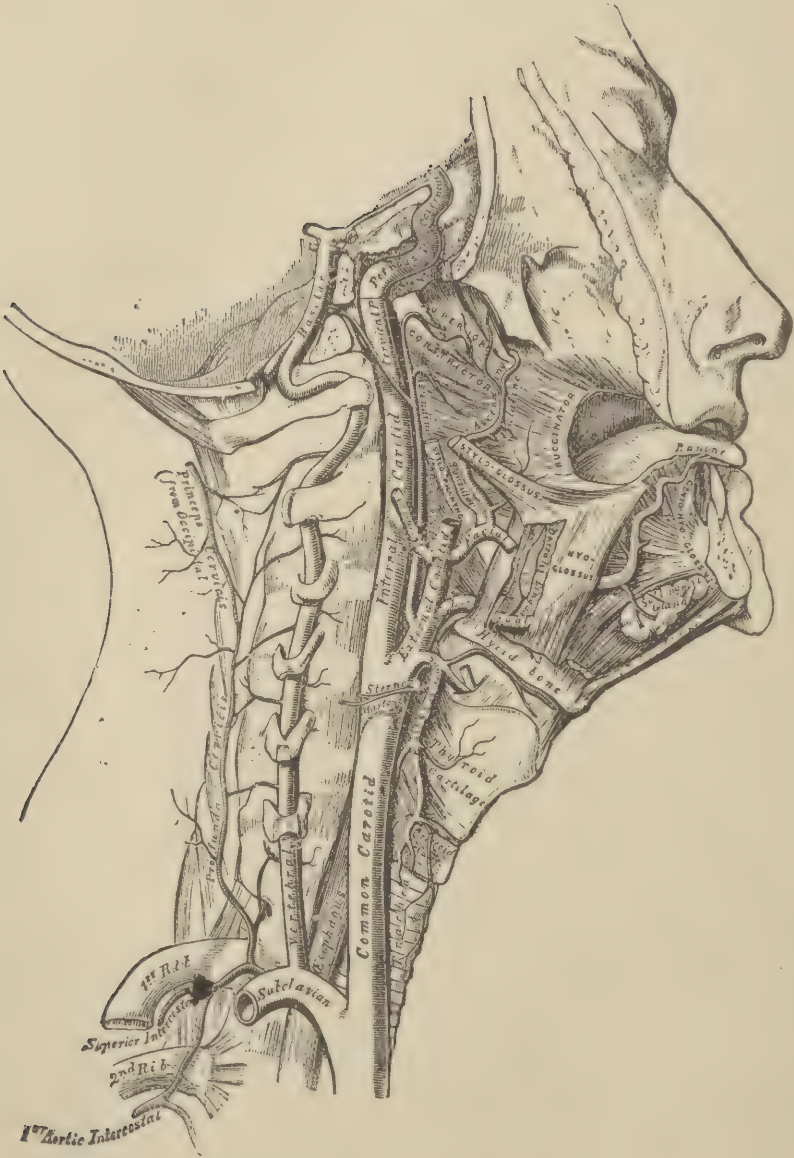
base of the brain. It gives off three *sets of branches*,—the external, or muscular; the internal, or pharyngeal; and the vertical, or meningeal. The latter enter the cavity of the cranium through different foramina, and are distributed to the dura mater (outer membranous covering of the brain). One meningeal branch enters by the jugular foramen, and another by the foramen lacerum medium.

The **temporal artery** appears, from its direction, to be a continuation of the external carotid. It takes its origin with the internal maxillary artery while imbedded in the substance of the parotid gland, and does not become superficial till it reaches the root of the zygoma, which it crosses almost vertically, and five centimeters (about two inches) above, divides into the anterior and posterior temporal; the anterior passing forward to inosculate with the supraorbital and frontal arteries; and the posterior running upward and backward to inosculate with the occipital and its fellow on the opposite side.

The **internal maxillary artery** is the large, deep, terminal branch of the external carotid. At its origin in the substance of the parotid gland it is on a level with the lower extremity of the lobe of the ear (auricle). At first it passes horizontally forward and inward at the inner side of the ramus of the jaw, then obliquely upward toward the superior maxillary bone, and, beneath the body of the sphenoid bone, gives off its terminal branches. It gives a "*tympanic*" branch to the tympanum (middle ear); a "*middle meningeal*" branch to the dura mater and cranium, through the foramen spinosum (a sphenoidal foramen); a "*small meningeal*" branch through the foramen ovale (another sphenoidal foramen); an "*inferior dental*" branch to the inferior dental canal; the "*deep temporal*," "*pterygoid*," "*masseteric*," and "*buccal*," to the muscles of mastication; an "*alveolar*" branch to the gums and antrum; an "*infra-orbital*" to that canal, in company with the superior maxillary nerve; a "*posterior palatine*" through that canal to the hard palate and gums; a "*Vidian*" branch through the Vidian canal to the Eustachian tube, pharynx, and tympanum; a "*pterygo-palatine*" to the pharynx and Eustachian tube; and a "*spheno-palatine*" to the mucous membrane of the nose, sphenoidal, and ethmoidal cells,—making in all fourteen branches of the internal maxillary artery that have been traced and named.

The **internal carotid artery** supplies the anterior part of the brain, and also the eye and its appendages. It has a common origin with the external carotid at the bifurcation of the common carotid, ascends through the upper part of the neck and carotid canal of the temporal bone, enters the cranium, and, near the anterior clinoid process of the sphenoid bone, divides into its terminal branches. In passing through the carotid canal, this blood-vessel turns almost a right angle, which tends to *break the force* of the current of the blood before entering the brain. This artery (the internal carotid) is usually described in four portions — the cervical (neck), the petrous (in the petrous portion of the temporal bone), the cavernous (lying near the cavernous sinus of the brain), and the cerebral. The latter forms the termination of the artery in the cerebrum.

Fig. 163.



ARTERIES OF THE NECK—RIGHT SIDE.

The *cervical portion* of the internal carotid artery passes through the superior carotid and submaxillary triangles (two of the five surgical triangles of the neck), but gives off no branches. The artery is, in the lower part of its course, more superficial, then passes beneath

the parotid gland, and becomes deeply situated behind and within the external carotid. It is attended by the internal jugular vein and pneumogastric nerve.

The *petrous portion* is contained in a bony canal just in front of the tympanum (drum, or middle ear), and is separated from the drum only by a thin plate of bone, through which it sends its first branch (the tympanic) to the middle ear. It is surrounded by the *carotid plexus* of nerves, and is separated from contact with the bony walls by a tubular process (sheath) of the dura mater (membrane around the brain). The tympanic artery, from the *internal* carotid, anastomoses in the tympanum with tympanic branches from the internal maxillary and stylomastoid arteries, which spring directly or indirectly from the *external* carotid; or, in other words, the middle ear is supplied by branches derived from both the internal and external carotid arteries.

The *cavernous portion* of the internal carotid gives off several small branches and one large trunk (the ophthalmic artery). The small branches, with one exception (the anterior meningeal), take the name of arteriæ receptaculi (arteries of the reservoir). They supply adjoining parts of the brain and dura mater. The anterior meningeal supplies the dura mater of the frontal region, and anastomoses with the middle meningeal artery, which is a branch of the internal maxillary from the external carotid.

The ophthalmic (relating to the eye) is the principal branch of the cavernous portion of the internal carotid. It leaves the cranium through the optic foramen (foramen opticum) in connection with the optic nerve. As it enters the orbit it lies on the outer side of the optic nerve in the direction of the lachrymal gland; but after giving off a branch (the lachrymal artery) to that gland, it crosses the optic nerve to the inner wall of the orbit, gives off a large branch (the supra-orbital), which runs forward above the globe of the eye and through the supra-orbital foramen, then continues horizontally forward to the inner angle of the eye, and terminates in two branches—the frontal and nasal arteries. Altogether, the ophthalmic artery gives off twelve branches. They are usually divided into two groups—the *orbital*, which supply parts within the orbit but *around* the eyeball, and the *ocular*, which supply the muscles and globe of the eye. The orbital group includes the lachrymal, supraorbital, posterior and anterior ethmoidal (supplying, respectively, the posterior and anterior ethmoid cells and some other parts), palpebral, frontal, and nasal. The ocular group includes the muscular (frequently two, supplying the muscles of the eyeball), three ciliary (anterior, short, and long), and the arteria centralis retinæ (central artery of the retina). The two largest

branches (supraorbital and lachrymal) of the ophthalmic artery (a branch of the *internal* carotid), anastomose with the facial from the *external* carotid.

The **supraorbital artery** passes through the supraorbital foramen with a nerve and vein of the same name, to supply the muscles and integument of the forehead and scalp (pericranium).

The **lachrymal** (tear) branch, or **artery** supplies not only the tear gland, but also the upper eyelid and conjunctiva.

The **palpebral** (eyelid), two branches, are given off near the pulley of the superior oblique muscle, and run along the margins of the upper and lower lids.

The **frontal artery** passes from the orbit at its inner angle, and anastomoses with the supraorbital upon the forehead.

The **nasal artery** runs along the back of the nose, and supplies its entire surface with blood.

The **three ciliary arteries** supply the ciliary processes, the iris, and the choroid coat of the eyeball.

The **arteria centralis retinæ** is a small artery with a long and interesting name —"central artery of the retina." It **pierces the sheath of the optic nerve** behind the eyeball, and runs forward, embedded within the nerve, to supply the retina (the inner coat of the eyeball). In the fœtus a small artery runs forward *through the globe of the eye* to the capsule of the lens.

The *cerebral portion* of the internal carotid artery gives off four branches — the anterior, and middle cerebral, the anterior choroid, and the posterior communicating.

The **anterior cerebral** supplies the olfactory and optic nerves, and some other anterior parts of the cerebrum (upper, or front brain).

The **middle cerebral artery** is the largest branch of the internal carotid, and is the direct continuation of it. It lies in the fissure of Silvius. (This fissure, named from Francis Sylvius, divides the anterior and middle lobes of the cerebrum on either side, and also at the base of the brain.)

The "**posterior communicating,**" on either side, runs backward from the internal carotid to reach the posterior cerebral from the basilar and vertebral arteries, and thus completes the "circle of Willis."

The anterior choroid ("skin-like," in respect to vascularity, or great number of blood-vessels) enters the descending horn of the lateral ventricle, and is distributed to the choroid plexus and other parts in the floor of the lateral ventricle. The *posterior* choroid artery is a branch of the posterior cerebral from the basilar artery. The latter is formed by the union of the two vertebral at the base of the brain. The verte-

bral are the largest branches of the subclavian, and the subclavian come directly or indirectly from the arch of the aorta; directly, on the left side, and indirectly through the "innominate," on the right side of the body.

The choroid plexus is a membranous fold of the pia mater ("soft mother, or nourisher,"—the inner of the membranes that envelop the brain), and is situated in the lateral, third, and fourth ventricles of the brain.

THE VEINS.

The veins return the blood from the capillaries of the body to, or toward, one of the auricles (little ears, or receivers) of the heart.

The pulmonary veins, usually four in number, return the arterial blood from the lungs to the left auricle of the heart.

The systemic veins, innumerable in number, but terminating, with the exception of those from the substance of the heart, in two large trunks (upper and lower vena cava), return the venous blood from the capillaries of the whole system to the right auricle of the heart.

The portal vein (vena portæ) returns the venous blood from the digestive organs to the liver, where it undergoes a change before it reaches the heart through the hepatic (liver) veins and inferior vena cava.

The veins are larger, more numerous, and contain more valves than the arteries. They communicate freely with one another by frequent anastomoses, both large and small branches.

There are three sets of veins,—the superficial, the deep, and the sinuses. The superficial veins are subcutaneous (just beneath the skin), and communicate with the deep veins by perforating the deep fasciæ. The **deep veins** usually accompany the arteries, often in the same sheath, and are called "venæ comites" (attending veins). The venæ comites bear the name of the artery which they attend. The hepatic veins and some others do not accompany arteries. The brachial, radial, tibial, and some other arteries, have each two accompanying veins. The larger arteries have usually only one accompanying vein.

The sinuses are venous channels of the encephalon (within the head), formed by division of the layers of the dura mater (outer and firm membrane that covers the brain).

The walls of the veins, like the arteries, are more or less supplied with elastic and muscular tissue. Most of them have an internal epithelial lining; but the epithelium (membrane of flattened cells, or scales) becomes lost as the veins approach the capillaries. In the veins of the lower extremities valves are very numerous. The valves

Fig. 164.

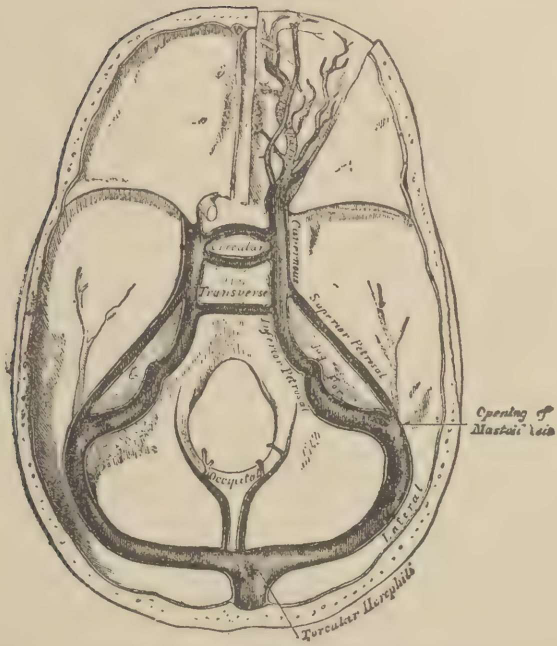
PORTAL VEIN AND ITS BRANCHES.

(The liver and stomach are here represented as turned upward, for the purpose of showing the portal vein.)

prevent the return of blood unless the veins are too much distended. The cardiac veins (sometimes called coronary) return blood from the substance of the heart directly into the right auricle. All other veins terminate finally in either the upper or lower *vena cava* (hollow vein).

The **venæ cavæ** (plural of vena cava) are the largest veins, or

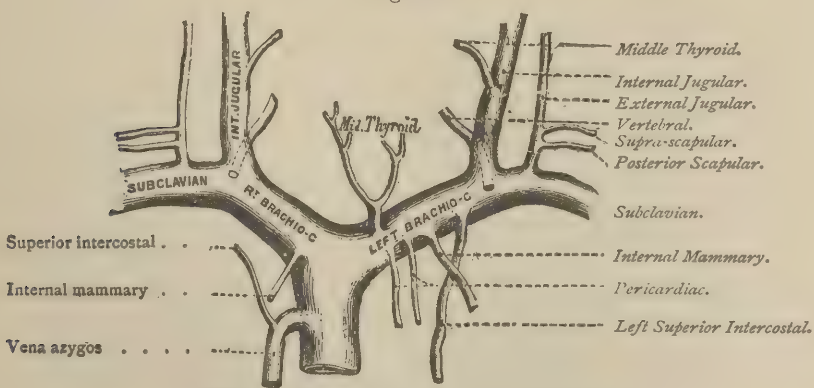
Fig. 165.



SINUSES AT THE BASE OF THE SKULL.

venous trunks, in the body. They open into the right auricle of the heart. The length of the superior vena cava is only about seven centimeters (three inches); the inferior about twenty centimeters (eight inches). The superior vena cava terminates at the upper and front

Fig. 166.



SUPERIOR VENA CAVA AND ITS TRIBUTARIES.

The brachio-cephalic (arm and head) veins are commonly called the innominate (nameless) veins.

part of the auricle; the inferior at the lower and back part of the same auricle.

There are two methods of studying the venous system. We may commence with the capillaries,— where we find millions of microscopic streams pouring into the veins blood loaded with waste matter and deprived of its oxygen,— or we may commence with the auricles of the heart,—where the veins, ultimately, all end,—and follow up the streams until we reach the capillaries and tissues of the body, where the blood commences its journey toward the heart.

The **venous blood** occupies the *right side* of the heart, and never the left, so long as the lungs perform their office of decarbonizing (removing the carbon) and oxydizing (charging with oxygen) the blood; and the **arterial blood** always occupies the *left side* of the heart. The veins of Thebesius (venæ Thebesii) are cardiac (heart) veins.

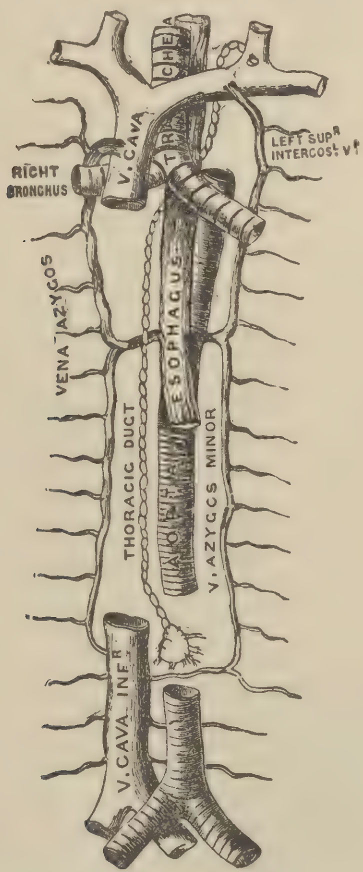
The **superior vena cava** is formed by the junction of the two (right and left) innominate veins, and corresponds to the ascending portion of the arch of the aorta. It extends from the right auricle to the first costal (rib) cartilage on the right side. Besides the innominate veins (venæ innominatæ) it receives the vena azygos (unpaired vein) just above the pericardium (heart-case), and also a few small veins. It has no valves.

The **azygos vein** collects blood from the intercostal spaces, and serves as a connecting link between the upper and lower vena cava. It arises from the inferior vena cava, or one of its branches (renal, or lumbar), and terminates in the superior vena cava. The azygos vein receives nine or ten lower intercostal veins, several œsophageal, mediastinal, and the vertebral veins, and near its termination the right bronchial vein. The azygos vein, proper, is generally designated as the "right azygos," or "vena azygos major," to distinguish it from two of its branches, which are called, respectively, the left lower and left upper azygos vein. The latter is sometimes wanting.

The **innominate veins** are two large trunks, one on either side, formed by the union of the subclavian and internal jugular veins. They have no valves. The left innominate is the longer, and runs transversely across the chest in front of the large branches of the aorta, to meet its fellow to the right of the median line. The right innominate vein is a short vessel, not more than four centimeters (one and a half inches) long, while the left is double that length. The right extends from the sternal end of the clavicle almost vertically downward, and meets its fellow just below the cartilage of the first rib. Each innominate vein receives, besides the subclavian and internal

jugular, which form it, the vertebral, the internal mammary, the inferior thyroid, and the superior intercostal veins. The right innominate usually receives, in addition, the right lymphatic duct; but on the left side the lymphatic duct is called the "thoracic" (chest) duct, and opens into the left subclavian vein. The right lymphatic duct opens into the right innominate at its junction with the right subclavian vein, *i. e.*, very *near* the right subclavian.

Fig. 167.



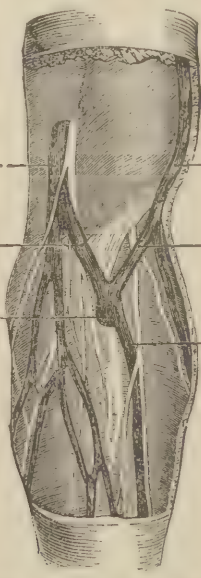
VENA AZYGOS—MAJOR AND MINOR.

The **bronchial veins**, originating in the lung substance, terminate on the right side (*i. e.*, the veins from the right lung) in the azygos vein; on the left side, in the superior intercostal, which is a branch of the innominate.

The **subclavian vein,** like the artery of the same name, is a con-

tinuation of the axillary vein, which is itself a continuation of the basilic, or a union of the basilic and brachial. The subclavian vein lies generally *in front* of the anterior scalene muscle, but sometimes behind it, with the artery of the same name. It extends from the outer margin of the first rib to the inner end of the clavicle, where it meets the internal jugular, and forms the innominate. It receives the external jugular, and also the anterior jugular. The posterior jugular is a *branch* of the external jugular; so that really there are but three (anterior, external, and internal) **jugular veins** on each side of the neck. Occasionally there is but one anterior jugular.

Fig. 168.



VEINS OF THE LEFT ELBOW.

The **axillary vein**, formed by the union of the basilic and brachial (the two venæ comites of the brachial artery, which generally unite before they join the basilic), receives branches corresponding with those of the axillary artery, and, in addition, the cephalic vein.

The **cephalic** is a superficial vein on the outer side of the arm, and formed at the elbow by the junction of the median cephalic and superficial radial. It received its name from the erroneous belief that it had more immediate connection with the head (κεφαλή, pronounced keph-a-lee).

The **basilic** (royal) **vein** is formed by the anterior and posterior ulnar (both superficial veins), and receives the median basilic near its origin in front of the elbow; or, we may say, it is formed by the union of the median basilic and ulnar veins.

Along the middle of the forearm, in front, is a vein called the **median**, which inosculates with the superficial radial and ulnar veins, and unites, at the bend of the elbow, with the **median basilic** and **median cephalic.** The latter run obliquely across the bend of the elbow, and can be distinctly seen beneath the skin. The median cephalic and median basilic are both quite short, and were the veins usually chosen, when blood-letting was practiced, for venesection, or phlebotomy (vein cutting) for blood-letting. Both words are identical in meaning, but the first (venesection) is from the Latin, and the other from the Greek language.

The **external jugular vein,** which opens into the subclavian, corresponds in part to the external carotid artery. It is formed, properly, by the union of the temporal and internal maxillary veins, but is usually described as formed by the temporo-maxillary and posterior auricular. The latter may be considered a branch of the external jugular. The external jugular commences near the point where the external carotid artery ends, in the substance of the parotid (near the ear) gland, and receives the greater part of the blood from the exterior of the cranium and deep parts of the face; or, in other words, returns blood from parts supplied by the external carotid artery.

The **internal jugular vein** (one on each side) collects the blood from the interior of the cranium, and from some superficial parts, also, and corresponds in large degree, but not wholly, to the internal carotid artery. It is formed at the jugular foramen (or posterior lacerated) by the union of two large sinuses of the brain (the lateral and inferior petrosal sinuses), descends vertically through the neck, on the outer side of the internal and common carotid arteries, to the root of the neck, where it unites with the subclavian vein, and forms the innominate. It receives the facial, lingual, pharyngeal, superior and middle thyroid, and the occipital veins of the same side.

The **vertebral veins,** one on each side, do not enter the cavity of the skull like the vertebral arteries, but collect the blood from *exterior* parts of the head and neck, and from the membranes of the spinal cord. The vertebral vein descends with the artery of the same name through the foramina (transverse) of the transverse processes of all the cervical vertebræ, except the last, and terminates at the back part of the innominate vein *near* the subclavian; while the vertebral *artery* is a branch of the subclavian.

The veins of the brain are superficial and deep. The superficial collect blood from the substance of the brain, and terminate in the sinuses (large venous channels formed by layers of the dura mater).

The **deep cerebral veins** are two in number, one from each lateral ventricle. Each of the deep (the ventricular veins) is formed by the union of the choroid vein, with the "vein of the corpus striatum" (vena corporis striati). The latter receives veins from the corpus striatum and optic thalamus (parts of the brain). The deep cerebral enters the the straight sinus.

The choroid vein runs along the outer border of the choroid plexus, and receives veins from the hippocampus major ("greater seahorse,"—an eminence of the brain at the posterior part of the lateral ventricle), the fornix (arch, or vault), and from the corpus callosum. The latter term is applied to a broad band of fibers which connect the right and left hemispheres of the cerebrum. "Corpus callosum" signifies "hard body."

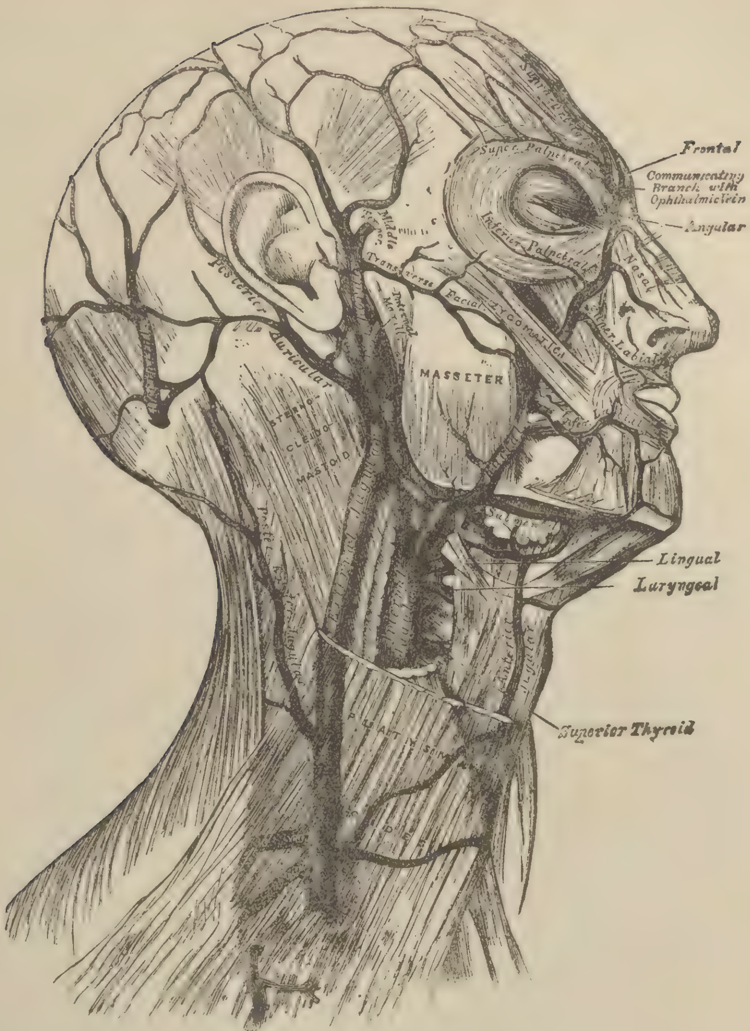
Fig. 169.

VERTICAL SECTION OF THE SKULL, SHOWING THE SINUSES OF THE DURA MATER.

The **sinuses** of the brain are 15 in number,—7 upon the upper and back portions of the brain, and 8 at its base. They are the superior and the inferior longitudinal, the straight, 2 lateral, 2 occipital, 2 cavernous, 2 superior and 2 inferior petrosal, the circular, and the transverse. The last eight lie at the base of the brain. From these sinuses the blood flows chiefly through the internal jugular veins back to the heart.

The **veins of the neck** return the blood from the head and face. As usually reckoned, they are ten in number, five on each side. Four of the five are jugular veins; the other is the vertebral. The jugular

Fig. 170.



VEINS OF THE HEAD AND NECK.

veins are distinguished as internal and external, anterior and posterior. The latter is a branch of the external jugular. The word "jugular" signifies some relation to a "yoke." The word "cervical" (relating to the neck) might be a more appropriate term for these veins.

The **veins of the head** may be grouped as veins of the *exterior*, and veins of the *interior* of the cranium (or skull). The veins of the exterior of the cranium are the facial, temporal, internal maxillary, temporo-maxillary, posterior auricular, and occipital. The veins of the

interior of the cranium include the cerebral veins, and the sinuses. The latter are large channels, or reservoirs for venous blood. The sinuses terminate in the internal jugular veins.

The **facial vein** is the direct continuation of the *angular* vein, and lies to the outer side of the facial artery. It joins the internal jugular vein. The **angular vein** is formed by the junction of the *frontal* and *supraorbital* veins. The frontal vein commences on the anterior part of the cranium, and communicates with the anterior branches of the temporal vein.

The **temporal vein** gathers blood from the side and vertex of the skull. Its several branches unite above the zygoma, and form the trunk of the vein. The trunk receives the blood from the temporal muscle, and then descends between the external ear-passage and condyle of the jaw, enters the parotid gland, and, uniting with the internal maxillary vein, forms the temporo-maxillary.

The **temporo-maxillary vein** descends in the substance of the parotid gland, and, in the space between the ramus (branch) of the jaw and the sterno-cleido-mastoid muscle, receives the posterior auricular vein and forms the external jugular. Near the angle of the jaw, the temporo-maxillary vein communicates with the facial, and thus connects the internal and external jugular veins.

The **posterior auricular vein** collects the blood from the side of the head behind the ear.

The **occipital vein** collects the blood from the back part of the vertex of the skull, and following the course of the occipital artery terminates in the internal jugular.

The diploë forms the middle portion of the walls of the skull; or, as more commonly described, it is the cancellous (open, or porous) tissue between the outer and inner tables of the skull. It is channelled in the adult by tortuous canals for the blood-vessels. The **veins of the diploë** (see Fig. 171) communicate with the meningeal veins and sinuses of the brain, and also with the veins of the pericranium (the membrane that covers the skull). Pericranium is only another name for the periosteum of the cranium.

The **inferior vena cava** collects the blood from all parts below the diaphragm, and corresponds to the abdominal aorta. It is formed by the junction of the two common iliac veins, passes upward along the front of the spine on the right side of the aorta, through a groove on the back part of the liver where it receives the hepatic (liver) veins, perforates the tendinous center of the diaphragm and pericardium, and terminates in the lower and back part of the right auricle of the heart. It receives in its course the following veins or branches; viz., lumbar,

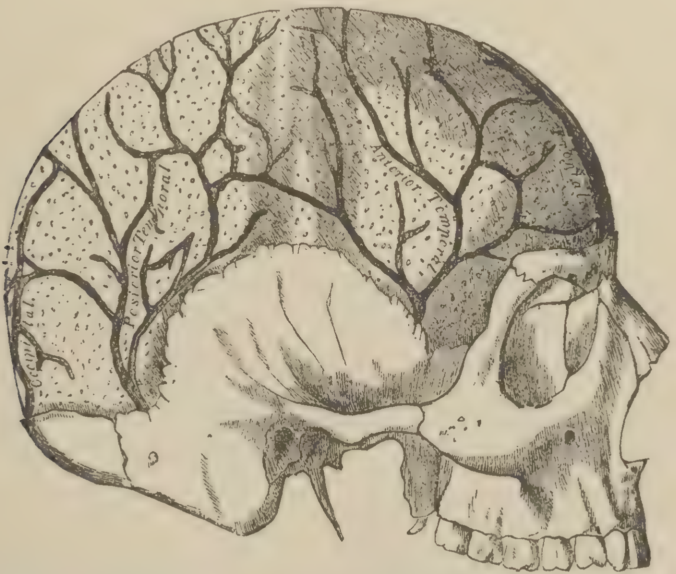
right spermatic, renal, supra-renal, phrenic, and hepatic veins. The left spermatic (in the female termed the ovarian) opens into the left renal vein.

The **lumbar veins**, three or four on each side, collect blood in the region of the loins, by means of dorsal and abdominal branches, and terminate at the back part of the inferior vena cava.

The two **renal veins** are of large size, and return the blood from the kidneys, corresponding to the branches and trunks of the renal arteries.

The **supra-renal vein** terminates on the right side, like the right spermatic (ovarian in the female) in the vena cava, and on the left in the renal, or phrenic vein.

Fig. 171.



VEINS OF THE DIPLOË; SHOWN BY REMOVING THE OUTER TABLE OF SKULL.

The **phrenic** (relating to the diaphragm) **veins** follow the course of the phrenic arteries. Those above the diaphragm (the superior phrenic), two in number, terminate, one (the right) at the upper part of the superior vena cava, the left, in the left upper intercostal, or left internal mammary vein. The two inferior phrenic (below the diaphragm) terminate, like the spermatic and supra-renal veins, the right in the inferior vena cava, the left in the left renal vein.

The **hepatic** (liver) **veins**, three in number, are short vessels conveying the blood of the liver to the inferior vena cava, as it lies imbedded

on the posterior border of the liver. The liver receives blood from both the hepatic artery and the vena portæ,—as the lungs receive venous blood from the pulmonary artery, and arterial from the bronchial arteries.

The **vena portæ** ("vein of the gate,"—relating to that part of the liver where the vessels enter as by a gate), or portal vein, is formed by the union of the superior mesenteric and splenic veins; but the splenic receives the inferior mesenteric, and also branches from the pancreas and stomach. The vena portæ receives the gastric, a small vein from the smaller curvature of the stomach; so that the portal system is composed chiefly of four large veins (superior and inferior mesenteric, splenic, and gastric) which collect the venous blood from the viscera of digestion. The **splenic** (spleen) **vein** is of large size.

The two **common iliac veins** are the primal branches of the inferior vena cava; or, we may say, unite to form it. They are distinguished as the right and left common iliac. Each common iliac is formed by the union of the external and internal iliac veins, and receives, as branches, the ilio-lumbar, and sometimes the lateral sacral veins. The left common iliac receives, in addition, the middle sacral, which is an azygos, or unmated vein. The internal iliac vein receives the internal pudic, the obturator, and all the venæ comites (associate veins) of the branches of the internal iliac artery except the umbilical.

The **external iliac vein**, like the artery of the same name, is a continuation of the femoral (thigh) vein; the line of demarkation being formed by Poupart's ligament (called, also, the crural, inguinal, or femoral arch). It receives immediately above this ligament the deep epigastric, and the circumflex iliac veins. The superficial epigastric, superficial circumflex iliac, and external pudic open into the internal saphenous vein near its junction with the femoral. The femoral receives the deep femoral near its termination, and the internal, or long saphenous, about four centimeters (one and a half inches) below Poupart's ligament. The external, or short saphenous vein, opens into the popliteal vein behind the knee. The popliteal also receives the sural and articular veins.

The **femoral vein** accompanies the femoral artery in the thigh, and, like it, becomes the popliteal vein in the popliteal space. The popliteal vein is formed by the junction of the venæ comites of the tibial vessels. The posterior tibial vein is formed by the union of the external and internal plantar veins. The anterior tibial veins are formed by the continuation of the veins from the back, or upper part of the foot—the venæ comites of the arteries.

Saphenous signifies "manifest," and the superficial veins of the leg and thigh were so called because they raise the skin, and manifest their course to the sight.

Fig. 172.

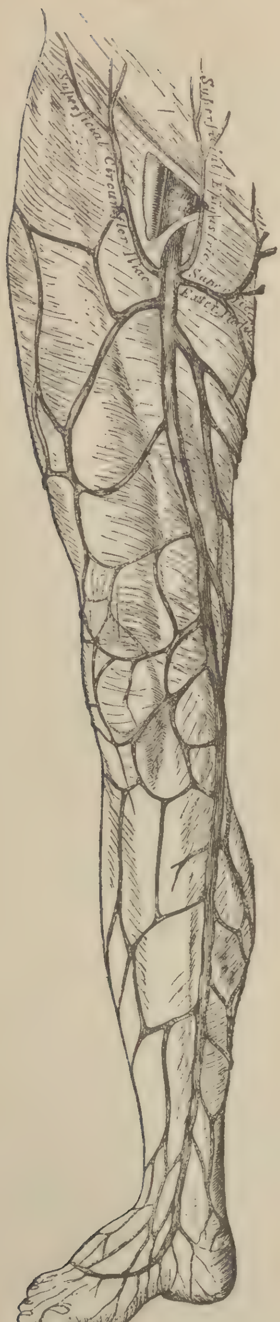


Fig. 173.

LONG (FIG. 172) AND SHORT (FIG. 173) SAPHENOUS VEINS, AND THEIR BRANCHES.

The two **saphenous**, or **superficial veins** commence in a **venous arch** situated on the dorsum ("back," or upper part) of the foot over the anterior extremities of the metatarsal bones. The arch is convex in front, and receives branches from the upper surface of the toes, and numerous small branches from the upper surface of the instep.

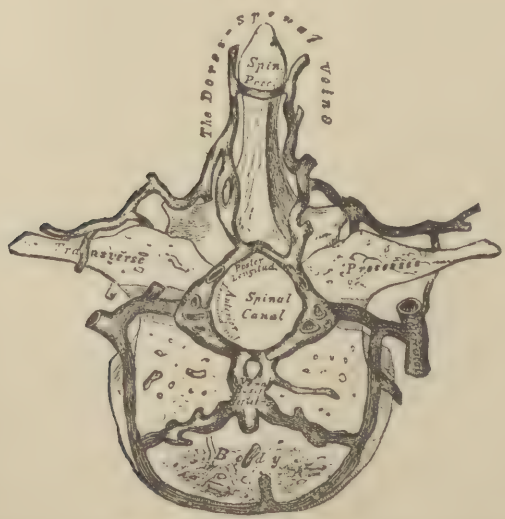
The **long saphenous vein** commences at the inner side of the arch, passes in front of the *internal malleolus* along the *inner* side of the leg and thigh to the saphenous opening in the fascia lata, through which it dips down to join the femoral vein. It receives in its course numerous cutaneous, or superficial branches, and, near the saphenous opening, the superficial epigastric, superficial circumflex iliac, and external pudic veins. Other large superficial veins from the back and inner part of the thigh frequently converge to join the saphenous vein near the saphenous opening.

The **short saphenous vein** commences at the other side of the arch, and passes behind the *external malleolus* to the middle line of the back part of the leg, from which it receives numerous branches. It perforates the deep fascia at the lower part of the popliteal space, and joins the popliteal vein between the two heads of the gastrocnemius muscle. It communicates with the deep veins on the back of the foot and behind the outer (or external) malleolus.

SPINAL VEINS.

Upon and within the spinal column are found numerous venous plexuses. Those on the exterior of the spinal column terminate by join-

Fig. 174.



SECTION OF A DORSAL VERTEBRA, SHOWING THE SPINAL VEINS.

Fig. 175.

1. Anterior external veins.
2. Dorsi-spinal veins.

3. Posterior longitudinal spinal veins.
4. Anterior longitudinal spinal veins.

SPINAL VEINS.

ing the vertebral veins in the neck, the intercostal veins in the thorax, the lumbar in the loins, and the sacral in the pelvis. These mostly terminate in the vena azygos (unmated vein). The latter terminates in

Fig. 176.

VERTICAL SECTION OF TWO DORSAL VERTEBRÆ.

the superior vena cava. The veins within the spinal column join the other spinal veins through the intervertebral foramina (openings between the vertebræ).

LYMPHATICS.

The lymphatic system consists of lymphatic vessels, including the lacteals; lymphatic ducts; and lymphatic glands, or lymph-nodes. The lymphatic vessels constitute a system of minute, delicate, transparent vessels, which have **their origin in the lymph spaces**, or capillary plexuses, of almost every organ in the body; and after passing through one or more lymph-nodes, or glands, finally empty into the veins and general circulation. These vessels resemble the veins, but are smaller and more numerous. They are often called absorbents, or simply lymphatics. They take their name from "lympha" (water), because they

generally carry a clear fluid resembling water, and called lymph; but the lymphatics of the alimentary canal, which take the special name of lacteals ("milky vessels," because they usually carry during digestion a milk-white fluid, or emulsion), convey the chyle ("juice" of the food) into the blood through the mesenteric glands and thoracic (chest)

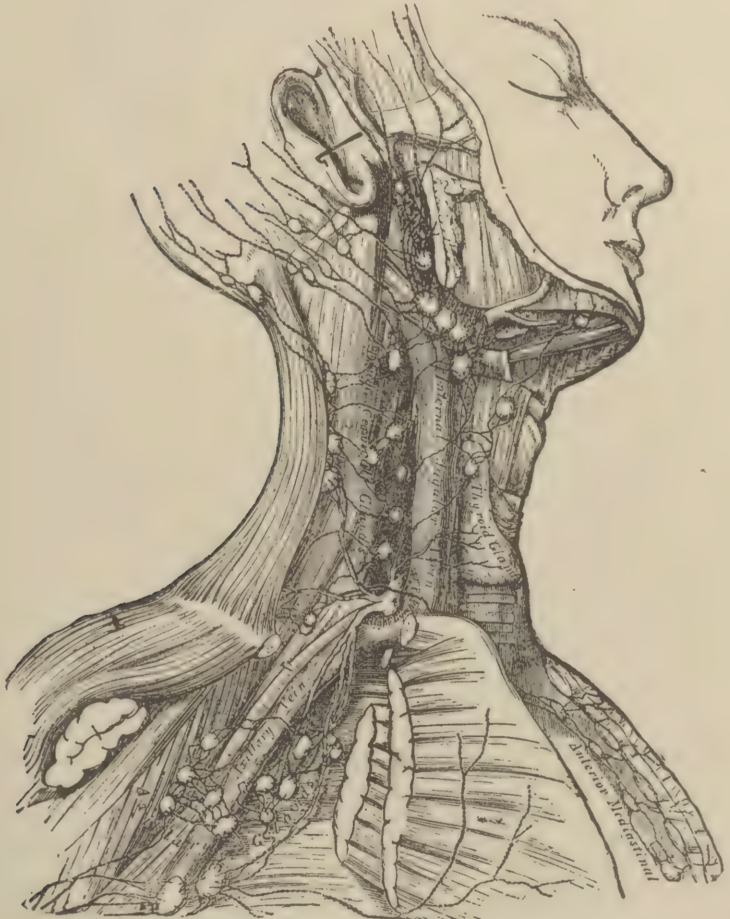
Fig. 177.

LYMPHATIC VESSELS AND GLANDS OF THE HEAD, FACE, AND NECK.

duct. The latter is the great lymphatic duct of the left side. The chyle scarcely differs from lymph, except it contains an emulsion of fatty matter not found in lymph. The lymph resembles blood in several particulars, but is destitute of color and of red corpuscles, and has a less specific gravity. Like blood, it is alkaline, of a saline taste, and when withdrawn from the vessels undergoes spontaneous coagulation.

Both chyle and lymph have white corpuscles (leucocytes), which resemble those of the blood; and in the chyle, are found immature red corpuscles. Placed in contact with oxygen, the lymph-clot, which contains white corpuscles, becomes of a scarlet-red color. On their way from the net-work of the tissues to the lymphatic ducts, which

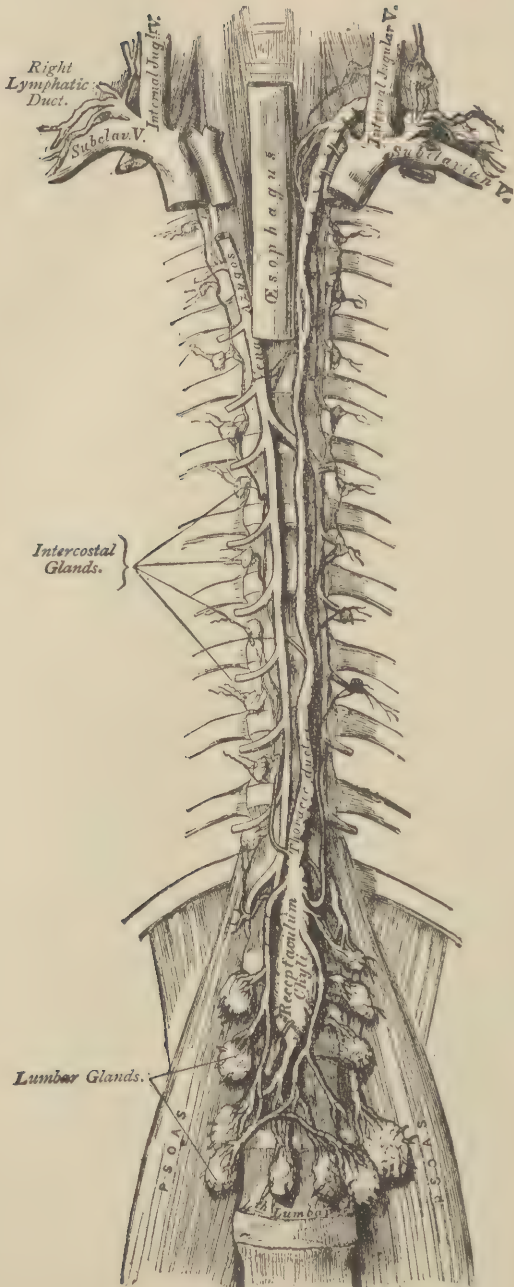
Fig. 178.



DEEP LYMPHATICS AND GLANDS OF THE NECK AND CHEST.

open into the veins, the lymphatic vessels pass through nodular masses, the "**lymphatic glands,**" which seem to have power to arrest certain poisonous substances which may find their way into the tissues, and thus prevent their entering the general circulation. These glands, or lymph-nodes, usually take the name of the part in which

Fig. 179.



THORACIC AND RIGHT LYMPHATIC DUCT.

Fig. 180.

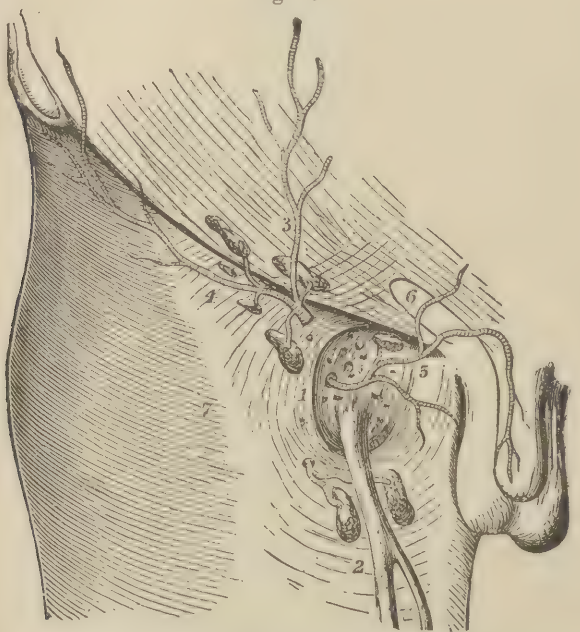
SUPERFICIAL LYMPHATICS AND GLANDS OF THE LOWER EXTREMITY.

they are situated, as axillary (armpit), inguinal (groin), mesenteric (mesentery), parotid (within and around the parotid gland, which is one of the salivary glands), lumbar (loin), etc.

The **lacteals** pass through the mesenteric glands, and finally empty their contents through the thoracic duct into the left subclavian vein.

The **thoracic duct** commences in the abdomen, a little below the diaphragm, in a dilated portion called the receptaculum chyli (reservoir of chyle). It receives the trunks of the lacteal vessels, and also vessels from the lumbar glands, and passes through the diaphragm and chest to reach the subclavian vein, near its junction with the internal jugular. A valve guards its entrance into the vein. The thoracic duct is the

Fig. 181.



INGUINAL REGION, SHOWING THE SAPHENOUS OPENING, CRIBRIFORM FASCIA, SUPERFICIAL VESSELS, AND GLANDS.

1. Saphenous opening of the Fascia Lata.
2. Saphena Vein.
3. Superficial Epigastric Artery.
4. Superficial Circumflexa Ilii Artery.
5. Superficial External Pudic Artery.
6. External Abdominal Ring.
7. Fascia Lata of the Thigh.

common trunk of the lymphatics of *all the lower part* of the body, and the *left side* of the upper part. Its average length is forty-two centimeters (about sixteen and a half inches).

The **right lymphatic duct** collects the lymph from the right side of the head, neck, right upper limb, and right side of the upper part of

the body. It opens into the vein at the angle of union between the internal jugular and right subclavian. The lymphatic vessels and glands are generally divided into superficial and deep, like the fasciæ and veins, but the distinction is unimportant.

The **mesenteric glands** number more than a hundred, and are supposed to aid in the elaboration of the chyle. They probably give birth to the white corpuscles of the blood. They are placed between the layers of the mesentery (folds of the peritoneum, which suspend the small intestine).

The **inguinal glands**, eight or ten in number, are divisible into two groups, upper and lower. The upper group, disposed along Poupart's ligament, receives the lymphatic vessels from the external organs of generation and adjacent parts; while the lower group, which surrounds the saphenous opening in the fascia lata, receives the lymphatic vessels from the lower extremity. These glands frequently become enlarged in disease which implicates the parts in which their vessels originate. In malignant disease of the upper extremity, or of the mammary gland, the axillary glands are usually found enlarged, as the lymphatic vessels from those parts pass through the axillary glands.

NEUROLOGY (NERVE-STUDY).

THE nervous system of the body comprises the nerves and nerve-centers; or, nerve-fibers and nerve-cells. The nerve-centers are termed ganglia (plural of ganglion — a knot). The nerves themselves are composed of one or more (sometimes nearly a hundred) nerve-fibers, each fiber forming a means of communication between two parts more or less distant from each other. The greater part of nerve-matter is contained within the cranium, and is called the encephalon ("in the head") — brain, or brains. The term "brain" is indefinite, and is applied to a part, or all of the encephalon. Through a great opening (foramen magnum) at the base of the cranium, the nerve-matter of the encephalon is continued down the back in a bony canal (the spinal canal), and forms the spinal cord (the "medulla spinalis," or spinal marrow, though it differs materially from the marrow of bones). The encephalon, which is divided by the tentorium (a firm membrane stretched horizontally between the two) into the "cerebrum" (large upper and front brain) and cerebellum (small, lower, and back brain), and the spinal cord, together, make up what is called the **cerebro-spinal center, or axis,** from which proceeds all the cranial and spinal nerves. The cranial nerves are those which leave the cranium (skull) through the openings (foramina) at its base, and the spinal nerves are those which leave the spinal canal through the openings between the vertebræ (intervertebral foramina). The cranial and spinal nerves are voluntary (under the control of the human will), and were called by Bichat (pronounced Bee-shar) **nerves of animal life,** in distinction from the sympathetic nerves, which he termed **nerves of organic life.** The latter are involuntary. Various ganglia within the body along the spinal column, but not within it, form the centers of the sympathetic nerves. These two kinds of nerves (voluntary and involuntary, or nerves of animal and organic life) are intimately connected; yet the nerves of animal life respond instantly and directly to the human will, while those of organic life act more slowly, and are only indirectly affected by the will.

Fig. 182.

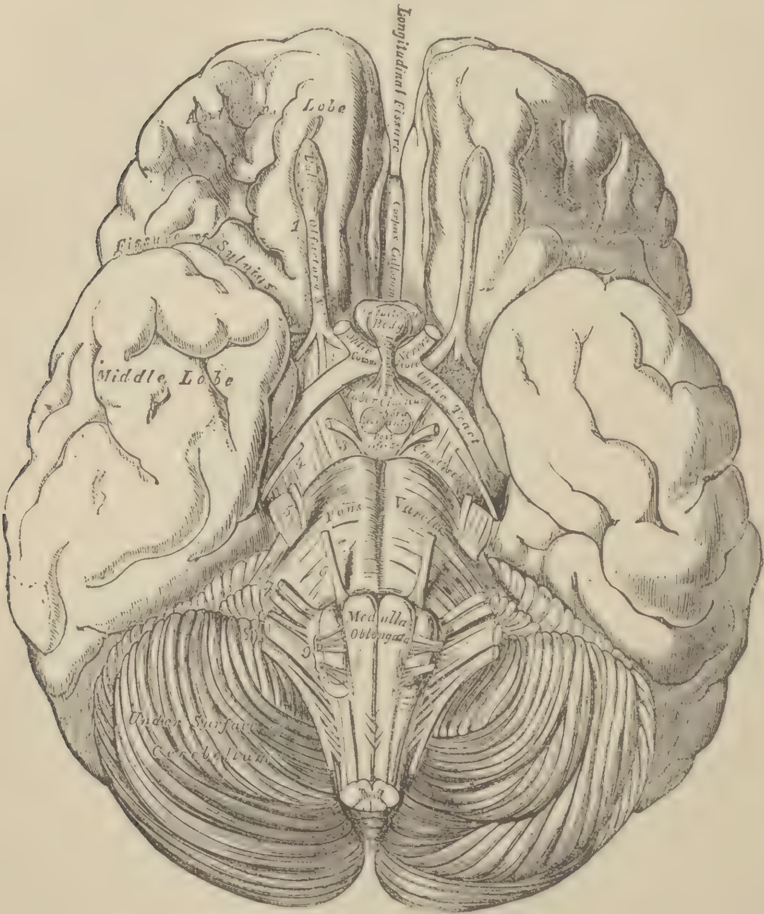
CEREBRO-SPINAL SYSTEM OF NERVES.

The encephalon (the mass of nerve-matter within the skull) includes a portion of the spinal cord,—the upper portion, called the "medulla oblongata" (oblong marrow). It is that part of the cord which lies within the cranium. The cord and encephalon are together invested by membranes ("meninges,"—Greek word for "membranes"). The outer membrane is called the dura mater (hard mother, or nourisher), and the inner, pia mater (soft mother). A third, the arachnoid, is described, by some authors, as a serous membrane consisting of two

layers, one lining the dura mater and the other covering the pia mater; and others consider these two layers of what is called the "arachnoid" as endothelial layers *belonging to the other two membranes* (dura mater and pia mater).

The arachnoid (spider-web form) is a colorless and transparent layer of the membrane which envelops the brain, and is separated from

Fig. 183.



BASE OF THE BRAIN.

the dura mater that lines the skull, by what is called the sub-dural space, which contains a limited amount of fluid. The arachnoid is more or less *connected with the pia mater* that immediately invests the brain, and cannot be readily separated from it; but there are places where the arachnoid is separated from the subjacent layer (usually

called the pia mater), and the spaces so formed are termed *subarachnoid* (under the arachnoid) *spaces*. There is one such space in the longitudinal fissure above the corpus callosum, and two of considerable size at the base of the brain. They are filled with a serous fluid (the cerebro-spinal), which communicates with the fluid of the general ventricular cavities of the brain, through an aperture (foramen of Magendie) in the fourth ventricle, and also through an opening on each side, behind the glosso-pharyngeal nerves. This fluid of the subarachnoid spaces and ventricles of the brain also communicates with that of the spinal cord, and for this reason is called *cerebro-spinal* (brain and spinal) fluid.

The membranes of the encephalon and cord are usually described separately on account of their peculiarities.

The **dura mater of the cord** is not adherent to the bones of the spinal canal as it is to the inner surface of the skull. It does not send partitions into the fissures of the cord as in the brain; and its laminæ (plates) do not separate to form sinuses (channels for venous blood) as in the brain. The **dura mater of the brain** (encephalon) is a dense, fibrous membrane which lines the skull, forming the internal periosteum. Its inner surface, next to the brain, is smooth, and covered by a layer of endothelial ("placed within") cells, similar to those which line serous membranes. It sends three prolongations into the cavity of the skull for the support of the different parts of the brain; two into the orbits through the sphenoidal fissures; and forms fifteen sinuses for the passage of venous blood. It also forms sheaths for the optic and olfactory nerves.

The three prolongations of the dura mater for the support of the different parts of the brain, are the two falces (plural of falx, and signifying "scythes," or sickles, so named on account of their shape) and the tentorium (stretcher). The two falces are the falx cerebri (scythe of the cerebrum), and the falx cerebelli (scythe of the cerebellum). The former divides the cerebrum (upper brain) into right and left symmetrical halves, or hemispheres; and the latter divides the right and left lobes of the cerebellum (lower or back brain). The falx cerebri occupies the longitudinal fissure between the two hemispheres of the brain, and is attached in front to the crista galli (cock's comb) of the ethmoid bone, and behind to the upper surface of the tentorium. It incloses at its upper and lower margins the superior and inferior longitudinal sinuses. The falx cerebelli (scythe of the cerebellum) is attached above to the under surface of the tentorium, and behind to the vertical crest (part of the crucial ridge) on the inner surface of the occipital bone. The tentorium is stretched horizontally between the

cerebellum and the posterior lobes of the cerebrum. It is somewhat arched over the cerebellum. It is attached behind by its convex border to the transverse portion of the crucial ridge of the occipital bone, and there incloses the lateral sinuses; in front, to the petrous portion of the temporal bones, where it incloses the superior petrosal sinuses; and from the apex of this bone is continued forward to the clinoid processes of the sphenoid bone. The tentorium and two falces being formed of the dura mater, are all firm membranes.

The **pia mater of the brain** is a thin membrane covered externally with endothelium, and containing an abundant supply of blood and lymph vessels. It invests the entire surface of the brain, dipping down between the convolutions and laminæ, and projecting inward to form the lining of the ventricles. It forms the velum interpositum (interposed veil) and the choroid (skin-like, because vascular) plexuses.

The **pia mater of the cord** is less vascular than that of the brain. It is also thicker and more dense in structure, and forms a sheath for

Fig. 184.

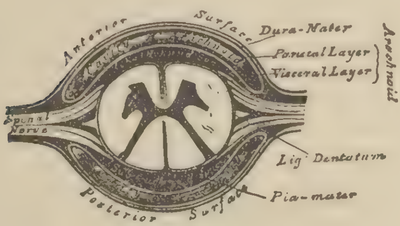
DIAGRAM TO SHOW THE FORMATION OF A SINUS.

1. Superior Longitudinal Sinus. 2. Inferior Longitudinal Sinus.

the spinal nerves. At the lower end of the spinal cord the pia mater becomes contracted, and forms a slender filament called the "**filum terminale**," (end thread), or coccygeal ligament, which descends through the center of the mass of nerves forming the "cauda equina" (horse's tail), and joins the dura mater below. The filum terminale retains the lower end of the cord in position, and for this reason is sometimes called the central ligament of the spinal cord. Three other ligaments connect the pia mater, which is intimately connected with the spinal cord, to the dura mater, which forms a loose sheath around the cord. These ligaments are narrow, fibrous bands that extend longitudinally along the sides and anterior surface of the spinal cord its entire length. The anterior ligament was called by Haller (Albert Von) the **linea splendens** (splendid line), and those at the sides received the name of toothed ligaments (ligamenta denticulata), on account of the points, or teeth, like those of a saw, on their outer borders, by which the ligaments are attached to the dura mater. By aid of the ligaments the spinal cord is

made to occupy the central part of the spinal canal, and the space between the investing membranes (dura mater and pia mater) is filled by a serous secretion, known as the *cerebro-spinal fluid*, which communicates with the matral and ventricular cavities of the brain. (Those anatomists who describe a third membrane — the arachnoid — divide the *matral* space, or serous cavity that intervenes between the dura mater and pia mater, into two parts — the *sub-dural* and *sub-arachnoid* space; and those who consider the arachnoid as a shut sack, call the serous cavity of the brain and spinal cord the *arachnoid* cavity.)

Fig. 185.



SECTION OF THE SPINAL CORD.

Fig. 186.

2, 2, LIGAMENTUM DENTICULATUM.

The bodies that are sometimes found upon, or beneath the dura mater of the brain, in the vicinity of the longitudinal sinus, and called **glandulæ Pacchioni** (glands of Pacchionus), are now believed to be abnormally enlarged papillæ (or villi) of the arachnoid membrane. The pressure of the circulation at these points either prevents the usual formation of bone over them, or wears pits, or depressions, in the inner table of the skull, much as the water wears pits, or pot-holes, in the bank, or rock, which borders it. They are not found in infancy, and rarely before the seventh year, and are said to increase as age advances.

THE SPINAL CORD (Medulla Spinalis).

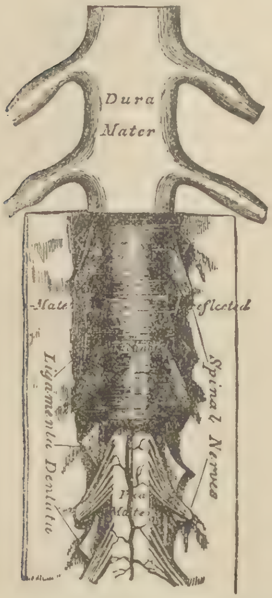
The spinal cord is that part of the cerebro-spinal axis which is contained in the spinal (or vertebral) canal. It is usually about forty-two centimeters (sixteen or seventeen inches) in length, and extends from the foramen magnum ("great opening" at the base of the brain) to the second lumbar (loin) vertebra, where it terminates in a filament of gray substance, called the filum terminale (end thread), among the leash of nerves forming the cauda equina (horse-tail).

In the embryo the spinal cord extends to the bottom of the sacral canal; at birth to the third lumbar vertebra, and is relatively

shortened by the growth and extension of the bones around it, or, in other words, by the thickening of the bodies of the vertebræ.

It lies loosely in its canal, its investing membranes being separated from the surrounding bony walls by areolar tissue and a plexus (network) of veins. In form it is a flattened cylinder, enlarged in the lower part of the neck and upper part of the loins, where it gives off nerves to the upper and lower extremities. Its weight in proportion to the encephalon, or brain, is about 1 to 33. It is surrounded by, or immersed in, a fluid—the "*cerebro-spinal fluid*," which, having free

Fig. 187.



THE SPINAL CORD AND ITS MEMBRANES.

Fig. 188.

SECTION OF THE SPINAL CORD.

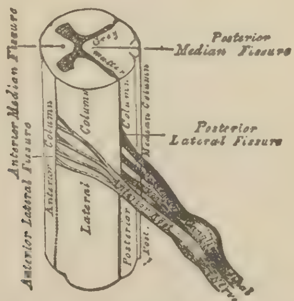
1. Dura Mater.
2. Arachnoid Membrane.
3. Ganglion on Posterior Root of a Spinal Nerve.
4. Anterior Root of a Spinal Nerve.
5, 5, Seat of Cerebro-spinal Fluid.
6. Posterior Branch of a Spinal Nerve.
7. Anterior Branch of a Spinal Nerve.

passage to and from the ventricles and lymph sinuses of the encephalon, regulates and equalizes the pressure upon the nerve-centers, and protects them from injury. Like the cerebrum (upper and front part of the brain and cerebro-spinal axis), the spinal cord is incompletely divided into two right and left symmetrical halves, by the anterior and posterior median fissures (or "antero-median," and "postero-median" fissure). These fissures do not cut the cord entirely, since the anterior median fissure extends into the cord only about one third of its thickness, leaving a band (the commissure) of nerve-substance the entire length of the cord, which unites the right and left sides.

The commissure of the cord, like the brain, is composed of two kinds of matter, gray and white. The gray matter is composed chiefly of nerve-cells, and the white of nerve-fibers. The gray matter occupies the central part of the commissure, and within it is a vertical canal, lined by epithelium, and called the *central canal of the spinal cord.* In the adult this canal can be seen, usually, only at the upper part of the cord, extending from the fourth ventricle about half an inch down the center of the cord, where it terminates in a cul-de-sac (blind alley); but prior to the sixth month of the fœtus, it extends the entire length of the cord, and sometimes remains pervious throughout.

Besides the anterior and posterior median fissures, which serve to divide the cord into halves, there are, on each side, three other vertical lines, which divide each half of the cord into four columns. The position of two of these lines is marked by the linear series of foramina, through which emerge the anterior and posterior roots of the spinal

Fig. 189.



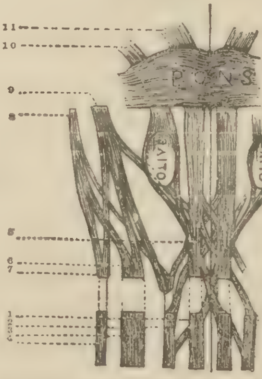
SPINAL CORD; ITS FISSURES AND COLUMNS.

nerves; and the third is marked by a slight furrow, which runs parallel, and near to the posterior median fissure of the cord. That part of the cord which lies between the anterior and posterior roots of the spinal nerves is called the "lateral (side) column"; the part in front of the anterior roots of the spinal nerves is called the "anterior column;" and the part behind the posterior roots of the spinal nerves forms the "posterior" and "posterior median" columns. The posterior median column is small, and lies adjoining the posterior median fissure. The three lines mentioned as dividing each half of the cord into four columns, all take the name of fissures, although in one case (where the anterior roots emerge) no actual fissure exists. They are named respectively the "antero-lateral," "postero-lateral," and "intermediate" fissures. On account of the absence of any fissure between the anterior and lateral columns of the cord, some anatomists include the

anterior *and* lateral columns under one name—the "antero-lateral column." The anterior column of the cord is continuous above with the "anterior pyramid" of the medulla oblongata; the lateral column of the cord is continuous with the lateral column of the medulla; and the posterior column of the cord is continuous with the restiform (rope-form) body of the medulla above.

In addition to these anatomical divisions of the spinal cord, there are others which are physiological. But before we give these latter divisions of the cord, we need to consider the gray matter which occupies nearly one third part of its interior. If we cut the cord transversely and examine the section (see Fig. 189), we find the gray matter arranged in the form of two crescents, one on each side, and

Fig. 190.



1. Anterior column
2. Lateral column.
3. Posterior column.
4. Posterior median column of the spinal cord.
5. Anterior pyramid.
6. Restiform body
7. Posterior pyramid.
8. Fasciculus teres.
9. Inferior crus of the cerebellum.
10. To the corpora quadrigemina.
11. Crus cerebri.

COURSE OF THE FIBERS THROUGH THE MEDULLA OBLONGATA.

connected by a transverse band of gray matter—the *gray* commissure (the central part of the commissure of the cord), each crescent having an anterior and posterior horn. The two horns of each side extend outward from the gray commissure toward the lines (called fissures) in which emerge the anterior and posterior roots of the spinal nerves. The posterior horn is more slender, and nearly reaches the surface of the cord. The anterior horn is short and thick, and its margin has a dentate appearance.

The gray matter of the cord is composed largely of nerve-cells, having from two to eight processes. These cells are of different shapes and sizes. The gray matter also contains nerve-fibers, blood-vessels, and connective tissue. The greater portion of the spinal cord, and all its exterior part, is composed of white matter, and consists largely of nerve-fibers. These fibers are mostly longitudinal, and arranged in groups forming the various columns of the cord. There

are, however, in the white substance, transverse and oblique fibers. These are principally found in the commissure, the fibers passing from the anterior horn of gray matter to the anterior column of white matter on the opposite side; from the roots of the spinal nerves to the gray matter; and, lastly, fibers leaving the gray matter to join the longitudinal fibers.

It is the white substance of the cord that is divided into columns. The "**column of Goll**" is identical with the "posterior median column," and lies on either side of the posterior median fissure. The "**column of Burdach**" is the "posterior column," and lies between the column of Goll and the posterior horn of gray matter. The **column of Turck** is at the anterior part of the cord, and lies adjoining the anterior median fissure, on either side. It is also called the "uncrossed pyramidal tract." The columns of Goll are small at the lower end of the cord, but become large and distinct in the cervical region.

The lateral columns are divided, each, into three divisions — the anterior part of the lateral column, the direct tract (to the cerebellum), and the crossed pyramidal tract. The two latter form the posterior part of the lateral column, and the direct tract is external to the "crossed pyramidal."

Having described the spinal cord, we need not be long detained by the description of the medulla oblongata, which is really the upper part of the spinal cord, but enlarged, and somewhat peculiar.

THE MEDULLA OBLONGATA.

This part of the cerebro-spinal axis is situated *just within* the foramen magnum (great opening), at the base of the brain. It extends along the basilar groove of the occipital bone to the lower border of the pons Varolii ("bridge of Varoli," named from Constantio Varoli, of Bologna). The columns of the cord are continued into the medulla, but their names are somewhat changed. The anterior columns of the cord become the anterior pyramids (or corpora pyramidalia — pyramidal bodies) of the medulla; the lateral column of the cord is the lateral tract (or column) of the medulla; the posterior column becomes the restiform (rope-form) body; and the posterior median column becomes the posterior pyramid of the medulla oblongata (so named to distinguish it from the main portion of the spinal cord, medulla spinalis). The anterior fibers of the two anterior pyramids of the medulla, derived from the anterior columns of the cord, are continued directly upward through the pons (bridge) to the cerebrum; but the innermost fibers, derived mainly from the deep portion (crossed pyramidal

Fig. 191.

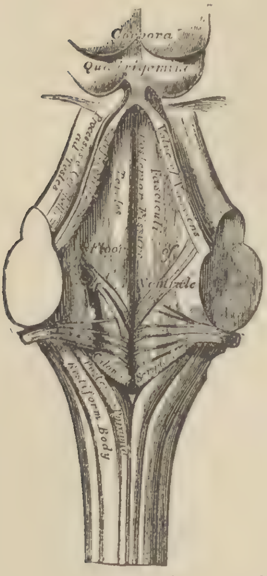
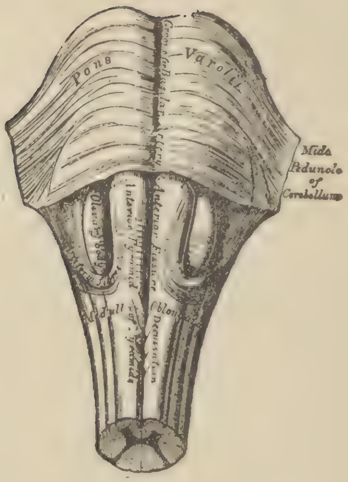
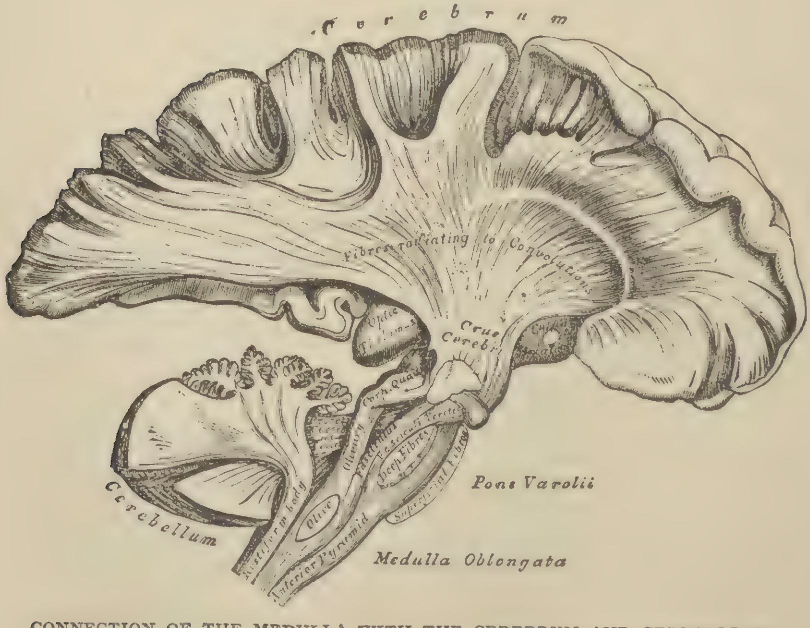


Fig. 192.



POSTERIOR (FIG. 191) AND ANTERIOR (FIG. 192) SURFACES OF THE MEDULLA OBLONGATA.

Fig. 193.



CONNECTION OF THE MEDULLA WITH THE CEREBRUM AND CEREBELLUM.

tract) of the lateral columns of the cord, decussate (intersect, or cross) with each other. This **crossing of fibers** from side to side takes place at the upper border of the atlas, or **just at the entrance of the skull.**

The lateral tract of the medulla contains the olivary body (so named, on account of its shape). This body contains a ganglionic mass of nerve-cells, called the **corpus dentatum** (dentate body). A ganglion of the same name is founed in the arbor vitæ (tree of life) of the cerebellum. The fibers from the lateral tract and dentate body pass upward to the cerebrum.

The **restiform bodies** from the posterior columns of the cord, are the largest columns of the medulla. They pass upward, on either side of the fourth ventricle, and enter the cerebellum, forming its inferior peduncles (footstalks). The posterior pyramids pass upward to unite with the restiform bodies, and enter the cerebellum.

The gray matter of the medulla is scattered throughout its entire substance.

The medulla gives rise to all the cranial nerves except four, and is supposed to contain the nerve-centers that preside over the acts of respiration, deglutition, phonation (use of the voice), expression, and, in large degree, the circulation of the blood. For these reasons the medulla is placed in the most secure part of the head. Its dimensions, in centimeters, are about 3 in length, $1\frac{8}{10}$ in width, and $1\frac{1}{5}$ in thickness; or in inches, $1\frac{1}{4}$, $\frac{3}{4}$, and $\frac{1}{2}$ respectively.

PONS VAROLII.

The **pons Varolii**, or "tuber annulare" (annular bulb) of some authors, and the medulla oblongata, are generally considered as a part of the cerebellum, but are described separately. The pons Varolii (bridge of Varoli) lies at the center of the base of the brain, just above, and in front of the medulla. It is a **bridge of nerves**, which cross from the medulla below to the cerebrum above, and, transversely, from one side of the cerebellum to the other; and is composed of alternate layers of transverse and longitudinal fibers intermixed with gray matter. Its under surface projects beyond the level of these parts, and has a longitudinal groove, which lodges the basilar artery. Its upper surface forms part of the floor of the fourth ventricle.

The **cerebellum** (back, or lower brain,—literally, "little, or small cerebrum") lies in the inferior occipital fossæ (lower cavities of the occipital bone), and beneath the posterior lobes of the cerebrum. Its average weight is about one ninth of the weight of the cerebrum, or a little less. The average weight of the entire brain, or encephalon, in-

cluding both the cerebrum and cerebellum, is about 1,488 grams (3 pounds). The maximum weight is 2,000 grams (2 kilos, or about 4 pounds). Average weight of the cerebellum, 170 grams.

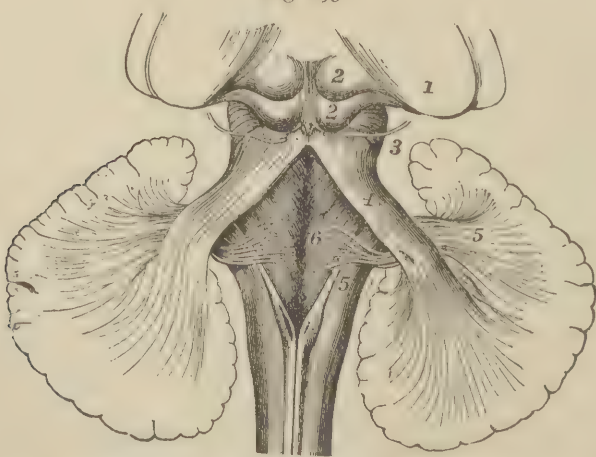
Fig. 194.

TRANSVERSE VERTICAL SECTION THROUGH THE BRAIN.

1. Corpus Callosum.
2. Lateral Ventricle.
3. Third Ventricle.
4. Corpus Striatum.
5. Thalamus Opticus.
6. Corpus Mammillare.
7. Choroid Plexus.
8. Fornix.
9. Pituitary Body.

The surface of the cerebellum is not convoluted, like the cerebrum, but furrowed in horizontal curves. Parts on the under surface are named "uvula" and "tonsils," or amygdalæ (almonds), from their resemblance

Fig. 195.



CORPORA QUADRIGEMINA (DOUBLE TWINS), FOURTH VENTRICLE, AND RESTIFORM BODIES.

1. Thalamus Opticus.
2. Nates and Testes, or Corpora Quadrigemina.
3. Origin of the Fourth Nerve.
4. Process from the Cerebellum to the Testes.
5. Restiform Bodies.
6. Origin of the Auditory Nerve.

to these parts of the throat. A vertical section of either hemisphere of the cerebellum reveals a foliated appearance, with a white central stem, which is called the **arbor vitæ** (tree of life); and within the white substance that forms the stem of the tree is a ganglion, called "corpus dentatum" (dentate, or toothed body). Another dentate body is found in the medulla oblongata.

Fig. 196.

VERTICAL SECTION OF THE CEREBELLUM (BACK BRAIN).

The **fourth ventricle** of the brain is situated between the pons Varolii and cerebellum, and is sometimes called the "ventricle of the cerebellum." It is lozenge-shaped, being broadest at its central part, and small above and below. It lies in a plane below the level of the base of the upper brain (cerebrum), and terminates below in the point of the "calamus scriptorius" ("writing-reed," or pen). The point of the pen is formed by the convergence of the posterior pyramids of the medulla oblongata below.

The two choroid plexuses of the fourth ventricle project into it on either side. The valve of Vieussens (pronounced Veeur-sonsse) is found in its roof. Its lining membrane is continuous with that of the third ventricle, through the "aqueduct of Silvius," the iter e tertio ad quartum ventriculum (way from the third to the fourth ventricle).

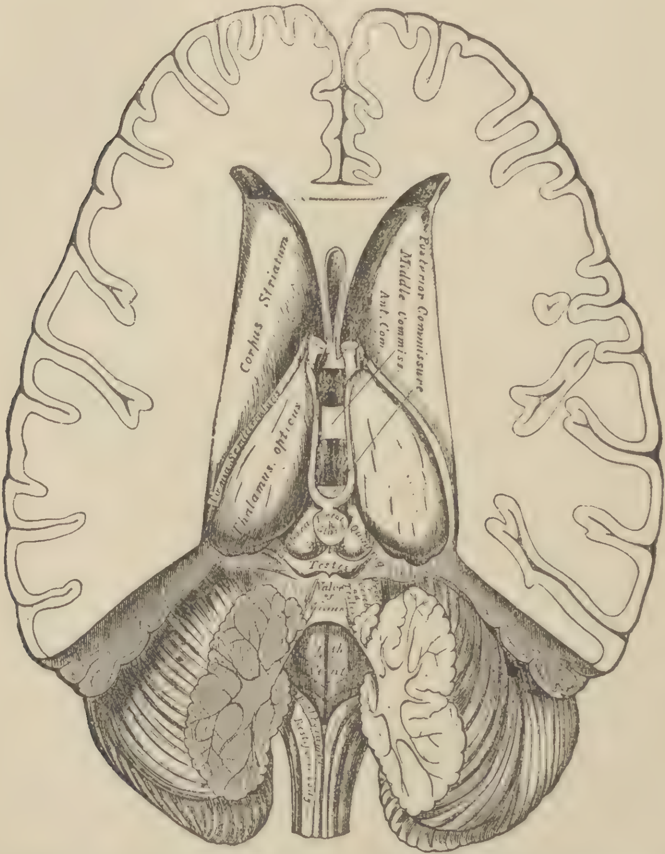
Some authors consider the fourth ventricle and aqueduct of Silvius as a continuation of the *central canal of the spinal cord* of the fœtus, which is thus made to extend to the third and lateral ventricles.

The parts of the brain which help to connect the cerebrum, cerebellum, and medulla oblongata, taken as a whole, are termed the **meso-cephalon** (middle of the head). The meso-cephalon includes the

pons Varolii, the crura cerebri (legs, or footstalks of the cerebrum), the peduncles (feet) of the cerebellum, the corpora quadrigemina (four twin bodies), and the pineal gland.

It was in the **pineal gland** (pinus,—a fir-cone, on account of its shape) that Descartes (pronounced Dacart′) placed the seat of the soul.

Fig. 197.



THE THIRD AND FOURTH VENTRICLES OF THE BRAIN (OR ENCEPHALON).

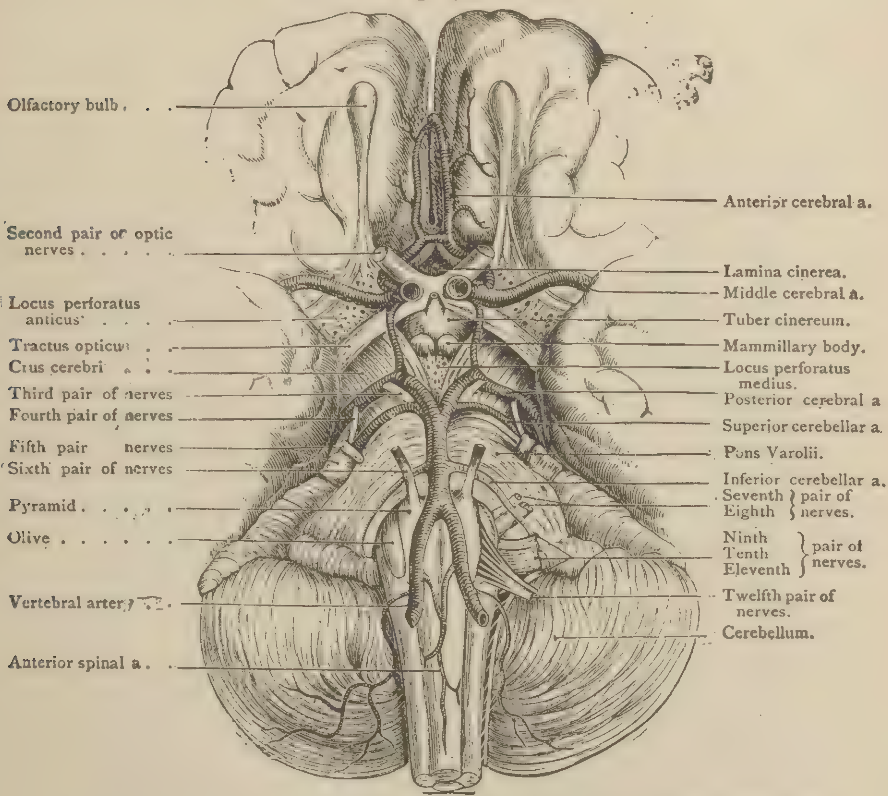
This section of the brain shows how the surface of the brain is increased by the depth of the sulci (furrows).

This body is situated between the fornix (vault) and the corpora quadrigemina. It is of reddish-gray color, and consists chiefly of nerve-cells. In dimensions it is about one centimeter (four lines, or four tenths of an inch) long, and less than that in width. At its base is a small cavity, which contains a transparent, viscid fluid, and usually some grains of earthy matter.

THE CEREBRUM (Brain).

The cerebrum constitutes the largest portion of the encephalon. It fills the anterior and middle fossæ of the skull, and rests behind upon the tentorium. Its upper surface corresponds in general outline with the vault of the cranium, being broader behind than in front, and ovoid in form. A median longitudinal fissure divides the mass of the cerebrum into two halves, or hemispheres, right and left, and numerous other fissures divide the hemispheres into lobes and convolutions.

Fig. 198.



UNDER SURFACE OF THE ENCEPHALON (ENTIRE MASS OF NERVE-MATTER WITHIN THE SKULL).

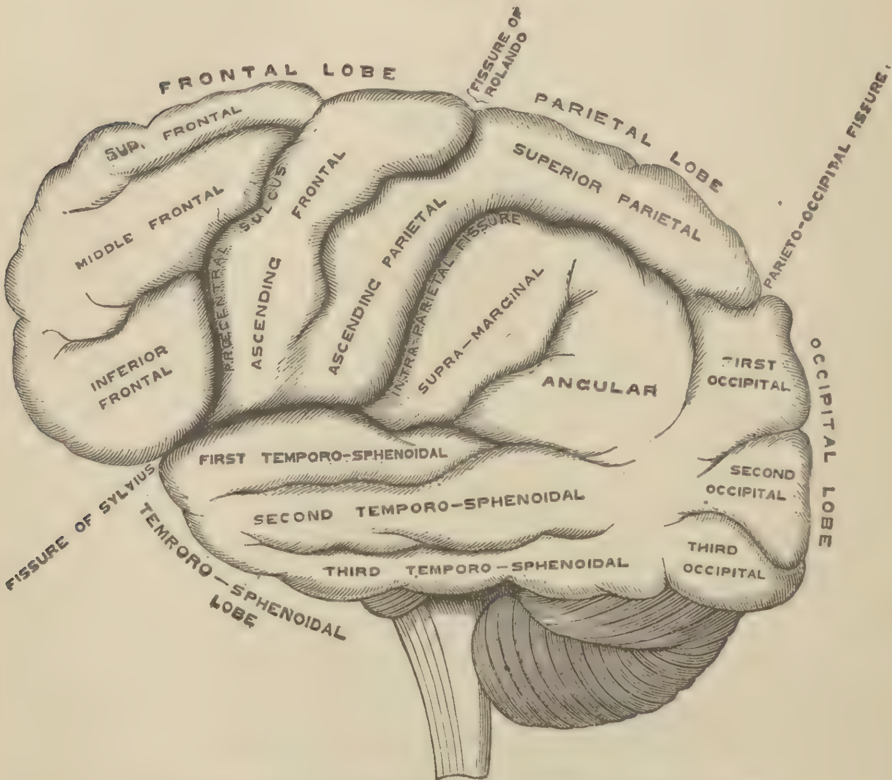
The mammillary bodies are also called corpora albicantia, locus perforatus (perforated space).

The **longitudinal fissure**, in front and behind, reaches down to the base of the cerebrum, but is interrupted in the middle by a broad, transverse commissure of nerve-fibers, which connects the two hemispheres, and is called the **corpus callosum** (hard body), or the great

commissure of the cerebrum. The length of the corpus callosum from before backward, is about ten centimeters (four inches). It is arched like the upper surface of the brain, is thickest behind, and thinnest at its central part, and forms the roof of the two lateral ventricles.

The **fissure of Sylvius** (Francis Sylvius) is one of the well-marked fissures of the cerebrum. On the under surface of the brain it sepa-

Fig. 199.



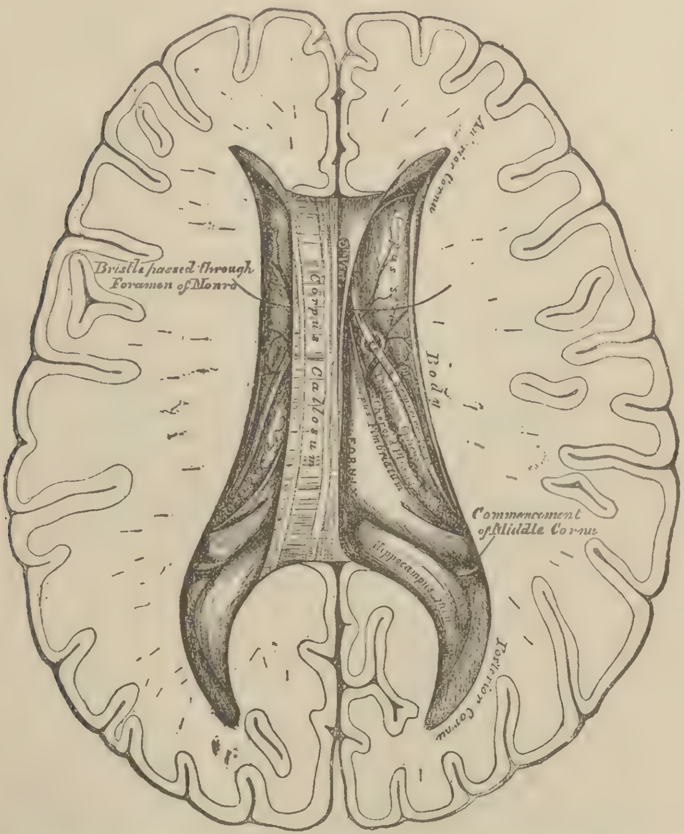
CONVOLUTIONS AND FISSURES OF THE OUTER SURFACE OF THE CEREBRAL HEMISPHERE.

rates the anterior and middle lobes of the cerebrum; and at the side (beneath the temporal and parietal bones) it divides the temporo-sphenoidal from the parietal lobe. This fissure contains the **middle cerebral artery**, which is the largest branch of the internal carotid. The **fissure of Rolando**, separates the frontal from the parietal lobe. It passes obliquely downward and forward from the upper part of the cerebrum toward the fissure of Sylvius. Another fissure, between the parietal and occipital lobes, is called the parieto-occipital fissure.

These are the principal fissures of the cerebrum; and the *frontal, parietal, occipital, temporo-sphenoidal*, and *central* (or island of Reil) are the principal lobes of the hemispheres which compose the cerebrum.

The **frontal lobe** lies in front of the fissure of Rolando, and above the fissure of Sylvius. It is subdivided into the *ascending frontal* (the posterior part of the frontal lobe), *inferior, middle*, and *superior frontal*. The **parietal lobe** is bounded by the fissure of Rolando, the parieto-occipital, and fissure of Sylvius.

Fig. 200.



THE LATERAL VENTRICLES OF THE BRAIN, AND, ON ONE SIDE, THE CORPUS CALLOSUM, WHICH FORMS THE ROOF OF THE VENTRICLE.

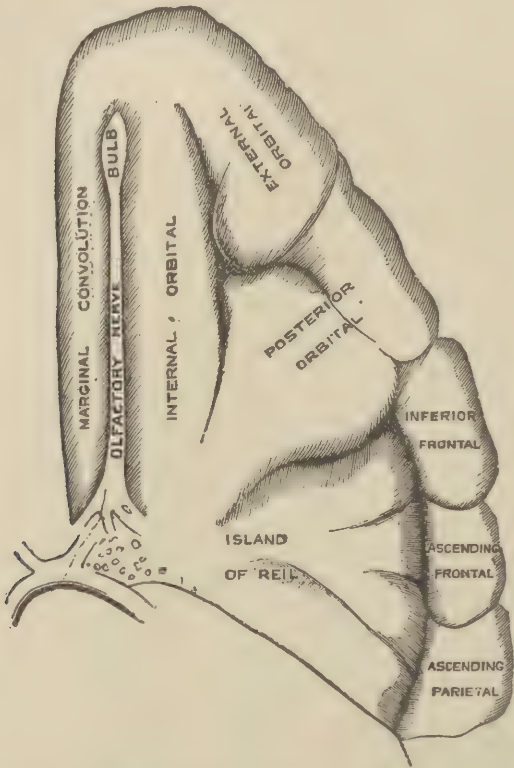
The **occipital lobe** occupies the posterior extremity of the brain beneath the parieto-occipital fissure. It is divided by some authors into the first, second, and third occipital lobes, but more properly into *superior, middle*, and *inferior*, like the frontal lobe.

The **temporo-sphenoidal lobe** is that portion of the hemisphere which lies at the side of the head beneath the fissure of Sylvius, and

rests in the middle fossa of the base of the cranium. This is also divided by minor fissures into three smaller lobes, one above another — superior, middle, and inferior; or first, second, and third.

The central lobe (or **island of Reil**) is situated at the base of the brain behind the frontal lobe (or, more particularly, behind the posterior orbital, which is a part of the frontal). The island of Reil is a triangular cluster of smaller convolutions (the gyri operti — covered convolutions).

Fig. 201.

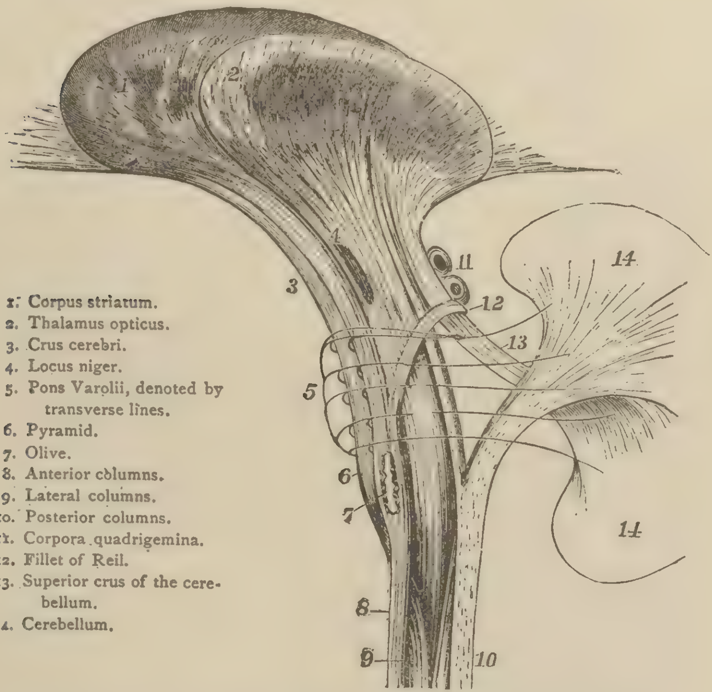


UNDER SURFACE OF THE ANTERIOR LOBE OF THE CEREBRAL HEMISPHERE, SHOWING THE ISLAND OF REIL, ETC.

On the inner surface of each hemisphere adjoining the median plane, or longitudinal sinus, the arrangement of convolutions is more simple. Taking the optic thalamus (chamber of vision), and arch of the corpus callosum (the great transverse commissure of the cerebrum) as the center of the inner surface, we find, surrounding this center, two layers of nerve-substance; and directly behind the corpus callosum, three layers. The first layer, next to the central parts just

mentioned, consists of only two convolutions (gyri)—the gyrus fornicatus (arched convolution) and the gyrus uncinatus (hooked convolution). The arched convolution surrounds the central parts on three sides (in front, above, and behind), and the other (the uncinate) extends beneath. The gyrus fornicatus is also called the convolution of the corpus callosum. The second, and, for the greater part of the circumference, the outer layer, is made up of three convolutions—the *marginal*, *quadrate*, and *third*, or *inferior temporo-sphenoidal*. The *marginal* lies upon and in front of the gyrus

Fig. 202.



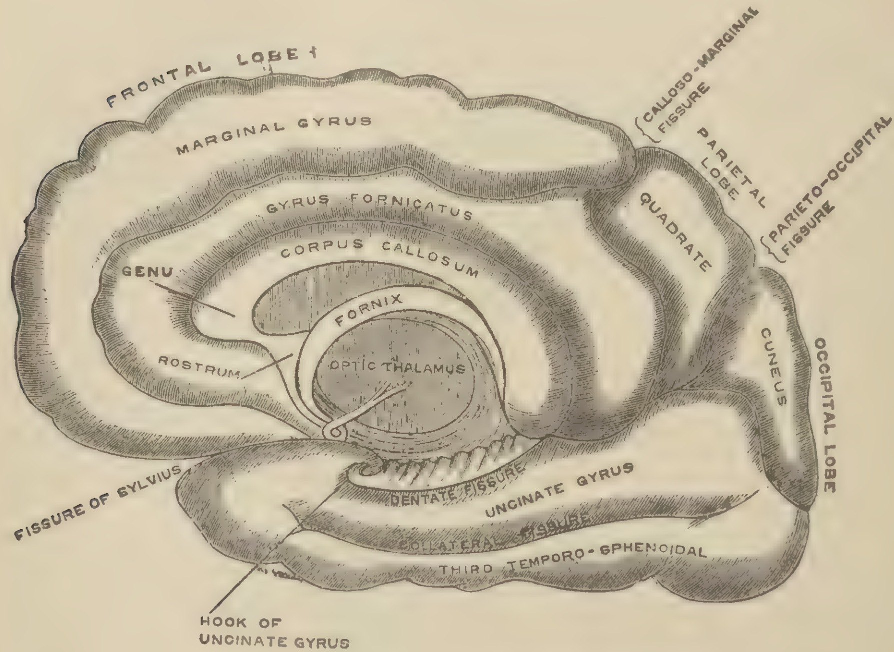
1. Corpus striatum.
2. Thalamus opticus.
3. Crus cerebri.
4. Locus niger.
5. Pons Varolii, denoted by transverse lines.
6. Pyramid.
7. Olive.
8. Anterior columns.
9. Lateral columns.
10. Posterior columns.
11. Corpora quadrigemina.
12. Fillet of Reil.
13. Superior crus of the cerebellum.
14. Cerebellum.

COURSE OF THE FIBERS THROUGH THE MEDULLA AND PONS.

fornicatus, but does not extend so far behind. It forms the margin of the hemisphere on either side along the longitudinal fissure. Behind the marginal convolution is the quadrate (square) convolution, which forms the outer layer in the region of the lambdoid suture, and near the median line. The second and outer layer, below, is formed by the third, or inferior, temporo-sphenoidal gyrus. The third layer of the occipital lobe, or region, is the cuneus (wedge-like), which is wedged in between the *square* and the two inferior lobes, or convolutions. Besides the convolutions mentioned, which may be considered

primary, there are numerous smaller convolutions, which make up the primary, and render their divisions somewhat obscure; but in a well-developed brain these primary convolutions may generally be recognized. One thing, however, must be specially noticed: the convolutions of the two sides are not generally symmetrical (alike on the two sides), but one side is folded differently from the other.

Fig. 203.



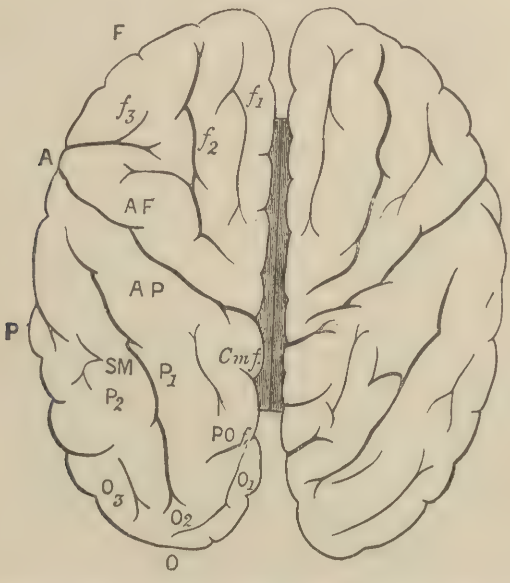
CONVOLUTIONS AND FISSURES OF THE INNER SURFACE OF THE CEREBRAL HEMISPHERE.

The number of convolutions and the depth of the fissures (or sulci signifying "furrows"), are determined by the extent of surface of the cerebrum: the larger the extent of surface, in proportion to the size of the skull, the more numerous the folds, or convolutions; and, in general, the deeper the sulci. Generally the sulci are two or three centimeters (or about an inch) in depth, but vary in different brains, and in different parts of the same brain. As we descend the scale of animal life, we find the convolutions diminish in number, and finally disappear, so that we may reasonably conclude that intellect, or capacity, generally depends largely upon the **extent of surface of the cerebrum.**

The outer surface of each convolution is composed of four, or more,

alternate layers of gray and white substance; the white substance, which is chiefly nerve-fibers, connecting the gray nuclei, or nerve-centers, with the various parts of the body. The gray matter at the surface of the brain is called the cortex (bark, or outer part), or cortical substance. Blood-vessels penetrate the cortex of the brain in the form of small arterioles from the pia mater, and form an abundant plexus in its substance.

Fig. 204.



CONVOLUTIONS OF THE UPPER SURFACE OF THE BRAIN.

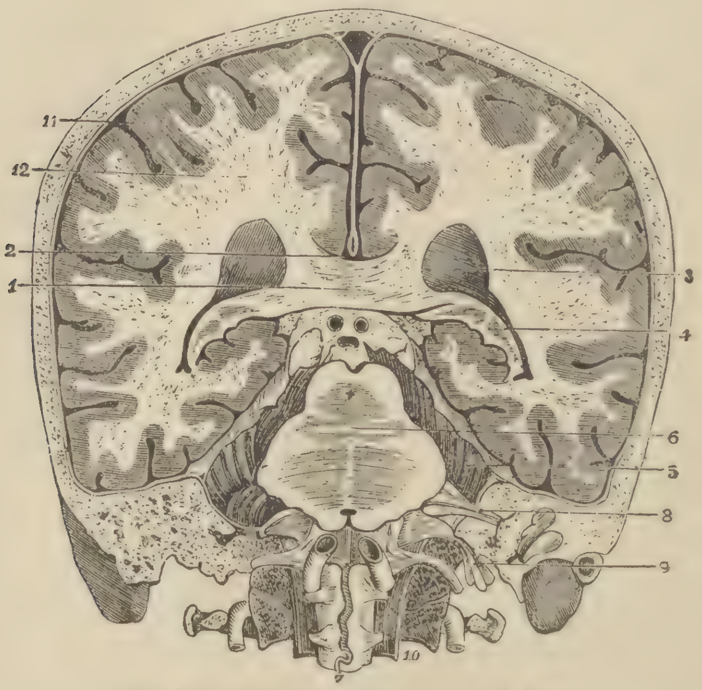
A. Fissure of Rolando.
A.F. Ascending Frontal Convolution.
A.P. Ascending Parietal Convolution.
S.M. Supra-marginal Convolution, below which is the Angular Gyrus.
P.O.*f.* Parieto-occipital Fissure.
F. Frontal Lobe.
P. Parietal Lobe.
O. Occipital Lobe.
f_1, f_2, f_3. Superior, Middle, and Inferior Frontal Convolutions.
P_1, P_2. Superior and Inferior Parietal Convolutions.
O_1, O_2, O_3. Superior, Middle, and Inferior Occipital Convolutions.
C. *m. f.* Calloso-marginal Fissure.

The under surface of the cerebrum, and the under surface of the entire brain (encephalon), are the same anteriorly, since the anterior and middle lobes of the cerebrum reach the base of the brain, but its posterior lobe rests upon the tentorium, above the cerebellum. At the base of the entire brain may be seen the base of the cerebellum, the medulla oblongata, the pons Varolii, the middle and anterior lobes of the cerebrum, the optic commissure, the pituitary body, the crura cerebri, the olfactory bulbs, the corpus callosum, and two fissures — the longitudinal (in front, where it reaches the base of the brain); and, lastly,

on either side, the fissure of Sylvius. Several of these parts have been already described.

The **optic commissure** lies in the median line at the base of the brain, and is the *point of junction* between the two optic nerves.

Fig. 205.



TRANSVERSE VERTICAL SECTION OF THE BRAIN.

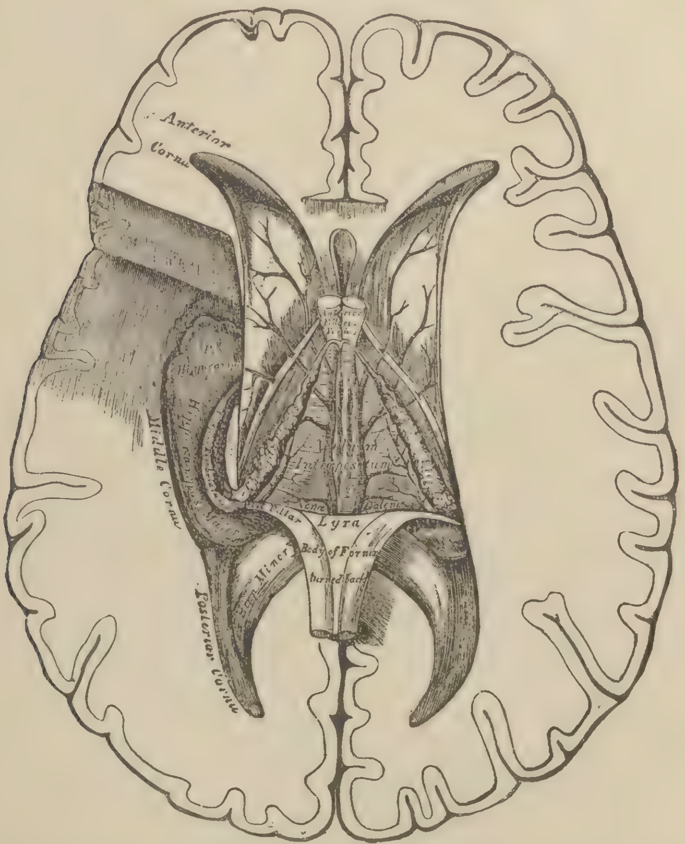
1. Corpus callosum in relation with the falx and the cerebral hemispheres.
2. Ventricle of the corpus callosum.
3. Lateral Ventricles.
4. Cornu Ammonis, white externally and grey internally.
5. Cerebellum, separated from the cerebrum by the tentorium.
6. Section through the corpora quadrigemina, aqueduct of Sylvius, and pons Varolii.
7. Medulla oblongata with the vertebral arteries and the anterior spinal branch in relation with it.
8. Auditory nerve, passing into the meatus auditorius internus.
9. Pneumogastric nerve passing through the posterior lacerated foramen.
10. Ninth nerve, passing through the anterior condyloid foramen.
11, 12. Grey and white substance of the convolutions. The fibres of the corpus callosum are shown radiating through the white to the grey substance.

The **pituitary** (relating to mucus, or phlegm) **body** was named from the supposition that it was concerned in the secretion of mucus. It occupies the Turk's seat (sella Turcica), but what particular part of the body it governs is unknown.

The **crura cerebri** (legs of the cerebrum), or peduncles (little feet) of the cerebrum, are two thick bundles of white matter, or bundles of nerves, which extend from the cerebrum, on either side, downward and inward (converging toward the median line) to the pons Varolii. Before

leaving the cerebrum, the crura, or roots of the cerebrum, pass through, on either side, two large ganglia, called the **optic thalami** (chambers of vision) and the **corpora striata** (furrowed bodies), which project from the upper and inner side of each peduncle. Above these ganglia is the great transverse commissure (the corpus callosum) of the cere-

Fig. 206.



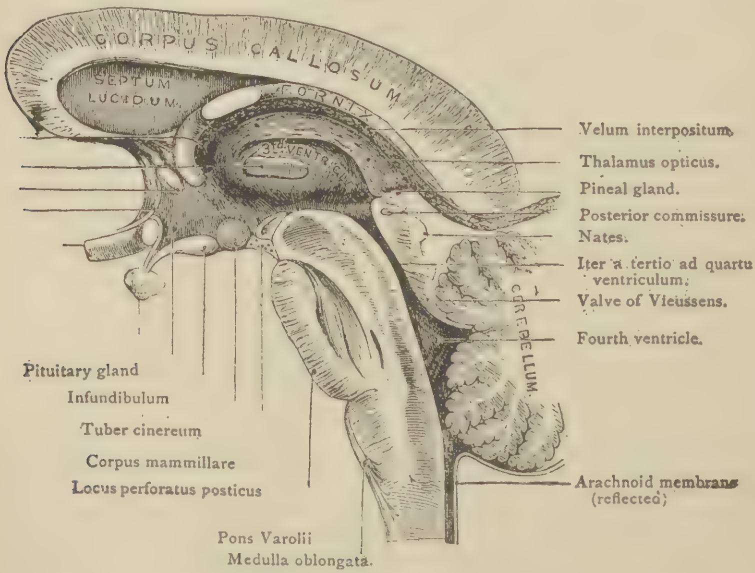
SECTION OF THE BRAIN, SHOWING THE CORNUA (HORNS) OF THE LATERAL VENTRICLES, THE HIPPOCAMPUS MAJOR AND MINOR, THE CHOROID PLEXUS, LONGITUDINAL FISSURE (AT THE FRONT AND BACK PARTS OF THE BRAIN), DEPTH OF THE SULCI (FURROWS), AND THE VELUM INTERPOSITUM.

brum; and the space left between the peduncles (the inter-peduncular space), and walled in by them, by the ganglia just mentioned, and by the corpus callosum above, forms the general ventricular cavity of the brain. The upper part of the ventricular cavity is subdivided by a verticle septum,—the **septum lucidum** (lucid wall),—and forms the two lateral ventricles; and the lower undivided part of the cavity forms the

third ventricle, which communicates with the lateral, on either side; above, by the foramen of Monro, and with the fourth ventricle, behind, by a way called "iter e tertio ad quartum ventriculum" (journey from the third to the fourth ventricle), or "aqueduct of Silvius."

The fifth ventricle is the space between the two layers of the septum lucidum, and can hardly be called a cavity, or ventricle, unless distended with fluid, which may occur in dropsy of the brain. We shall content ourselves by barely mentioning the *names* of the lamina cinerea (ashy plate), the anterior and posterior perforated space, the tuber cinereum (ashy bulb), the infundibulum (funnel-shaped), and the corpora albicantia (white bodies), all of which lie at the middle part of the base of the brain.

Fig. 207.



VERTICAL SECTION THROUGH THE CORPUS CALLOSUM AND PARTS BELOW.

Directly beneath the corpus callosum, on either side of the septum lucidum, and formed by the upper part of the general ventricular space in the interior of the brain, are the **lateral ventricles** (side cavities). These are two serous cavities, one in each hemisphere, which contain more or less serous fluid. Each lateral ventricle consists of a central cavity and three smaller cavities, or cornua (horns), the anterior, middle, and posterior cornu (horn). The anterior horn curves forward and outward in the substance of the anterior lobe of the brain, or cerebrum; the posterior horn curves backward and outward, and then

inward, into the posterior lobe of the cerebrum; and the middle horn descends into the middle lobe of the cerebrum. In the floor, or bottom, of the *central* cavity are found the following parts, enumerated in their order from before, backward: the corpus striatum (the plural is "corpora striata," striated bodies), tænia semicircularis (semicircular ribbon), thalamus opticus (optic chamber), choroid plexus ("skin-like net-work," or fold of the pia mater, resembling the skin in vascularity, or multitude of vessels), corpus fimbriatum (fringed body), and fornix (arch, or vault).

Fig. 208.

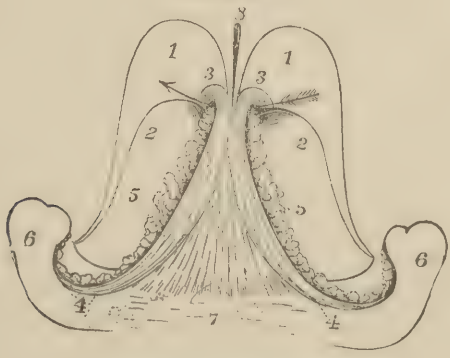


DIAGRAM OF THE FORNIX.

(The arrow is passed through the foramen of Monro.)

1, 1. Corpora Striata.
2, 2. Thalami Optici.
3, 3. Anterior Crura of Fornix, bending down to join the Corpora Mammillaria.
4, 4. Posterior Crura of the Fornix, joining the Hippocampi.
5, 5. Choroid Plexus.
6, 6. Hippocampi Majores.
7. Corpus Callosum, cut through
8. Ventricle of Septum Lucidum.

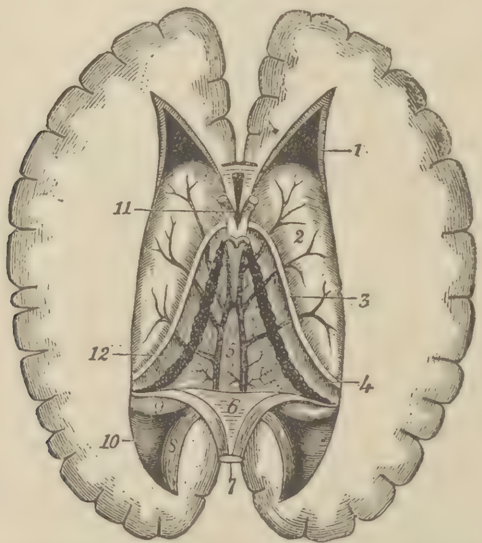
On the floor of the posterior horn of the lateral ventricle is the **hippocampus minor** (smaller sea-horse), while the **hippocampus major** (larger sea-horse) extends along the floor of the middle horn of the ventricle. The hippocampus major is also called "cornu ammonis" (horn of Ammon), from its resemblance to a ram's horn.

The **fornix** is a longitudinal plate of white fibrous matter, situated beneath the corpus callosum (hard body). It consists of two symmetrical halves, one for each hemisphere, joined together in the middle line, but separated from one another in front and behind, and forming the anterior and posterior crura of the fornix. The anterior crura of the fornix arch downward toward the base of the brain, separated from each other by a narrow interval. They are connected in their course with the optic commissure. The posterior crura of the fornix are intimately connected by their upper surfaces with the corpus callosum.

They diverge from one another, and pass downward into the descending horn of the lateral ventricle. The crura of the fornix (vault) are also called the "**pillars**" **of the fornix.** On the under surface of the fornix are some transverse lines, and others oblique, which, from a fancied resemblance to the strings of a harp, have given to this part of the brain the name of "**lyra**" (harp).

The **Velum Interpositum** (interposed veil) is a membrane reflected from the pia mater, which separates the under surface of the body of the fornix (vault) from the cavity of the third ventricle. On its under surface are the choroid plexuses of the third ventricle. This interposed veil covers the corpora quadrigemina, the pineal gland, and optic thalami.

Fig. 209.



LATERAL VENTRICLES AND VELUM INTERPOSITUM (INTERPOSED VEIL).

1. Anterior Horn.
2. Corpus Striatum.
3. Tænia Semicircularis.
4. Optic Thalamus.
5. Velum Interpositum, with the Venæ Galeni.
6. Lyra.
7. The posterior half of the Fornix, turned backward.
8. Hippocampus Minor.
9. Hippocampus Major.
10. Eminentia Collateralis.
11. Fifth Ventricle.
12. Choroid Plexus.

The **Optic Thalami** (chambers of vision) are two large, oblong masses of white and gray matter that embrace the crura (roots, or footlets) of the cerebrum (upper brain).

The **corpora quadrigemina** (four twin bodies) are also called "tubercula quadrigemina" (four twin little bulbs) and "optic lobes." They are situated behind the third ventricle, in front of the cerebellum,

and beneath the posterior border of the corpus callosum. The anterior pair are termed the "nates" (buttocks), the posterior, "testes" (witnesses).

Twelve ganglia, or nerve centers, are generally enumerated as parts of the brain or encephalon. These are the cerebrum, cerebellum, medulla oblongata, 2 olfactory bulbs, 2 corpora striata, 2 optic thalami, 2 corpora quadrigemina, and the tuber annulare. These are mostly groups of nerve-centers.

The average weight of the encephalon is about 50 ounces. The cranial capacity varies from 75 to 125 cubic inches.

To remove the brain, the anatomist must sever or divide the scalp (including the occipito-frontalis, the aural [extrinsic, or outer muscles of the ear] and temporal muscles), the skull, or cranium, the meninges, 12 pairs of cranial nerves with their attending vessels, 4 arterial trunks (2 internal carotid and 2 vertebral arteries), the internal jugular veins and sinuses, and, lastly, the spinal cord.

We have now described the cerebro-spinal axis (brain and spinal cord), with its meninges, or coverings. To complete the description of the voluntary nerves, we must describe the nerves that proceed from the brain and spinal cord; but we shall better understand the description of these nerves after knowing something of their structure.

Each nerve of the body, *so called*, is a cord, or *bundle of nerves*, containing, sometimes, several dozen nerve-tubes or fibers, each tube forming a distinct nerve, and running a separate and independent course to its destination. Each tube, or nerve proper (for what we call a nerve is a nervous cord) contains in its center an axis cylinder, surrounded by a white substance, that isolates it from other nerves. This white substance is sometimes called the medullary sheath, or, more commonly, the "white substance of Schwann." Around the white substance (medullary sheath) is a fine, transparent envelope, called the primitive sheath. The axis cylinder, the white substance that surrounds it, and the primitive sheath, together make up a nerve-fiber. The nerve-fibers are united in bundles, or "funiculi" (little ropes), by a tissue called neurilemma (nerve-coat), and the funiculi are all bound together in one large bundle by a sheath called the perineurium (around the nerve).

The nerves do *not inosculate* like the blood-vessels; and however they may decussate, or form plexuses (networks) among themselves, each primitive nerve, or nerve-fiber, runs a distinct course.

The afferent (bearing *to*, or toward) nerves carry impressions toward a nerve-center, and are generally sensory nerves; while the efferent (bearing from) nerves carry impressions outward, and are generally motor nerves (causing motion, or action).

Two kinds of nervous matter are found in the nervous system. These have already been mentioned as white and gray matter. The white matter is also called "fibrous" and "medullary"; and the gray is often called "vesicular" (containing vesicles) and "cineritious" (ashy). The principal distinction to be remembered is the function of each. The *gray matter* is a **nerve-center**, where the nervous impression originates; while the *white, fibrous matter* serves to **transmit impressions** to distant parts. The gray matter is softer, contains more water, less albumen, and less fat, than the white nervous matter, and is composed of **nerve-corpuscles** (little bodies).

Each nerve-corpuscle is a cell, or vesicle (little bladder), containing a **nucleus** (a kernel), and within the nucleus, a nucleolus (little kernel). The **nucleolus** is sometimes peculiarly clear and brilliant.

Fig. 210.

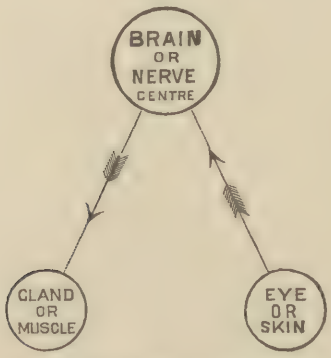


DIAGRAM SHOWING THE DIRECTION OF NERVE-IMPULSES, AND ILLUSTRATING WHAT IS USUALLY CALLED "REFLEX ACTION."

The nerve-cells, or corpuscles, vary in size and shape. In the sympathetic, or involuntary system, they are more nearly spherical; in the cerebro-spinal system, often stellate (like a star), or caudate (having tails, or processes).

The fibrous matter is of two varieties,— the tubular and gelatinous. The latter belongs to the sympathetic system, but is often found intermingled with the tubular. The gelatinous nerve-fiber is much like the axis cylinder of the tubular-fiber deprived of its white substance and sheath. It is composed of a fine, transparent material.

The **ganglia** (knots) may be regarded as little brains, or nerve-centers, distributed in various parts of the system. They are found on the posterior root of each spinal nerve; on the posterior root of the fifth cranial nerve; on the facial (seventh cranial) nerve; the glosso-pharyngeal; the pneumogastric; in a connected series on each

side of the vertebral column, forming the double axis, or trunk, of the sympathetic system; and, lastly, upon branches of the sympathetic nerves in various parts of the body.

The terminations of a nerve are distinguished as central and peripheral (relating to the circumference, or outer path). The central termination may be traced to the cerebro-spinal axis, or other ganglionic center.

The afferent ("bearing to," or toward a nerve-center) nerves are also called "*centripetal*" (seeking the center) nerves, and the efferent ("bearing from" the nerve-center) nerves, "*centrifugal*" (fleeing from the center) nerves. The centrifugal are motor nerves; the others sensory, or sympathetic.

CRANIAL NERVES.

Those nerves that have their apparent origin within the cranium are called cranial nerves. Sommering and anatomists on the continent of Europe reckon **twelve pairs of cranial nerves.** Willis, Gray, and some other authors include all the cranial nerves in nine pairs. The latter arrangement has reference to the *mode of exit* from the cranium. The seventh and eighth of Sommering leave the cranium through the internal ear-passage (meatus auditorius internus), and the ninth, tenth, and eleventh, through the jugular foramen. For this reason Willis considered the seventh (facial) and eighth (auditory) as one pair; and also the ninth (glosso-pharyngeal), tenth (penumogastric, or par vagum), and eleventh (spinal accessory) as one pair. The arrangement of Sommering, who has twelve pairs, is much more simple, and has reference to the *function of the nerves*, or parts of distribution. But without choosing between these two numerical classifications, we shall avoid all confusion by avoiding the numerical designation of all cranial nerves above the sixth pair, as the first six pairs are identical in both arrangements.

The names of the cranial nerves, in both arrangements, taken in the order in which they pass out of the cavity of the cranium, and commencing in front, are as follows: —

1st, Olfactory.
2d, Optic.
3d, Motor Oculi.
4th, Pathetic (or trochlear).
5th, Trifacial (or trigemini).
6th, Abducens.

Fig. 211.

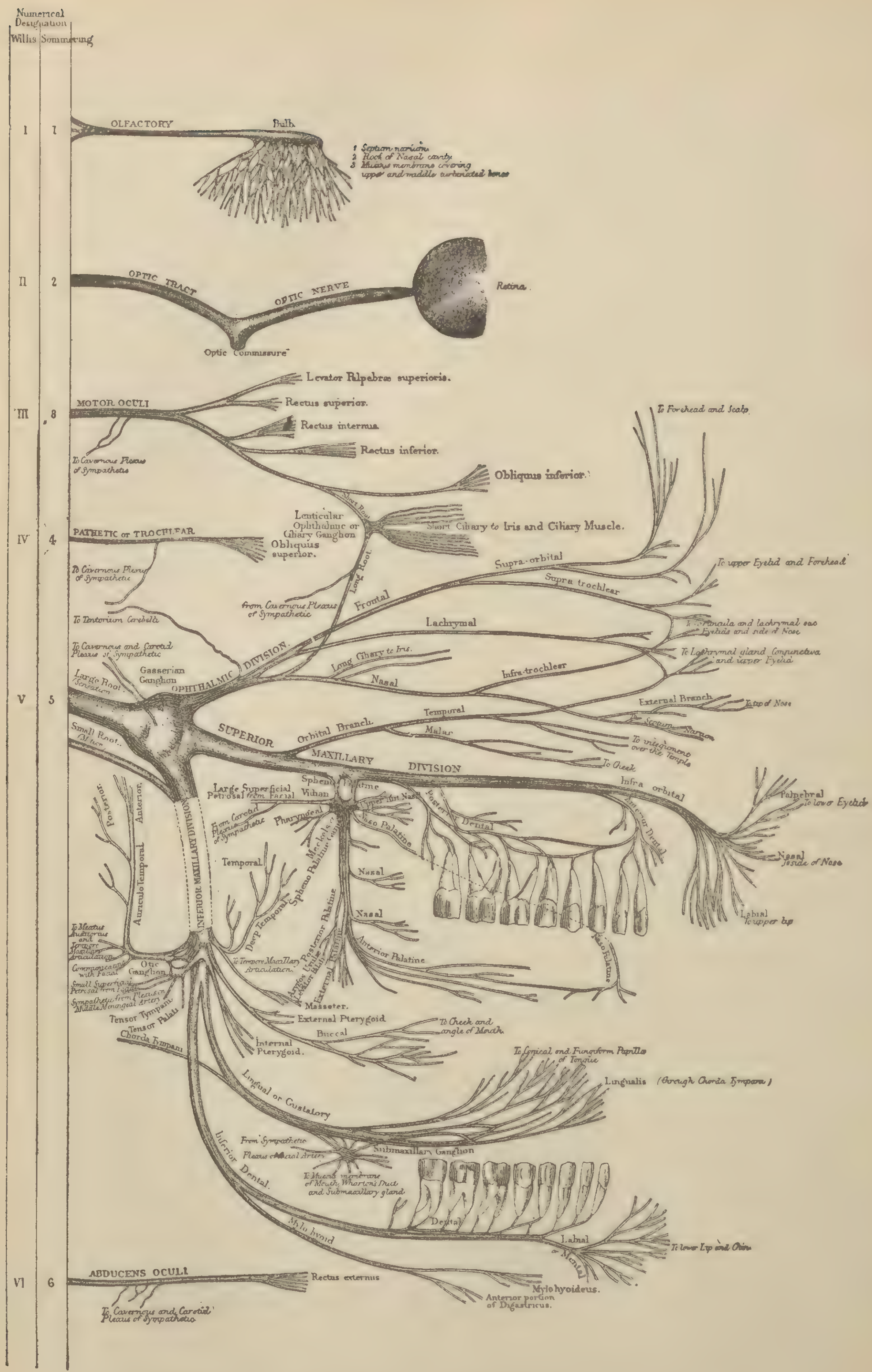


DIAGRAM OF THE FIRST SIX CRANIAL NERVES, WITH THEIR CHIEF BRANCHES OF DISTRIBUTION.

Fig. 212.

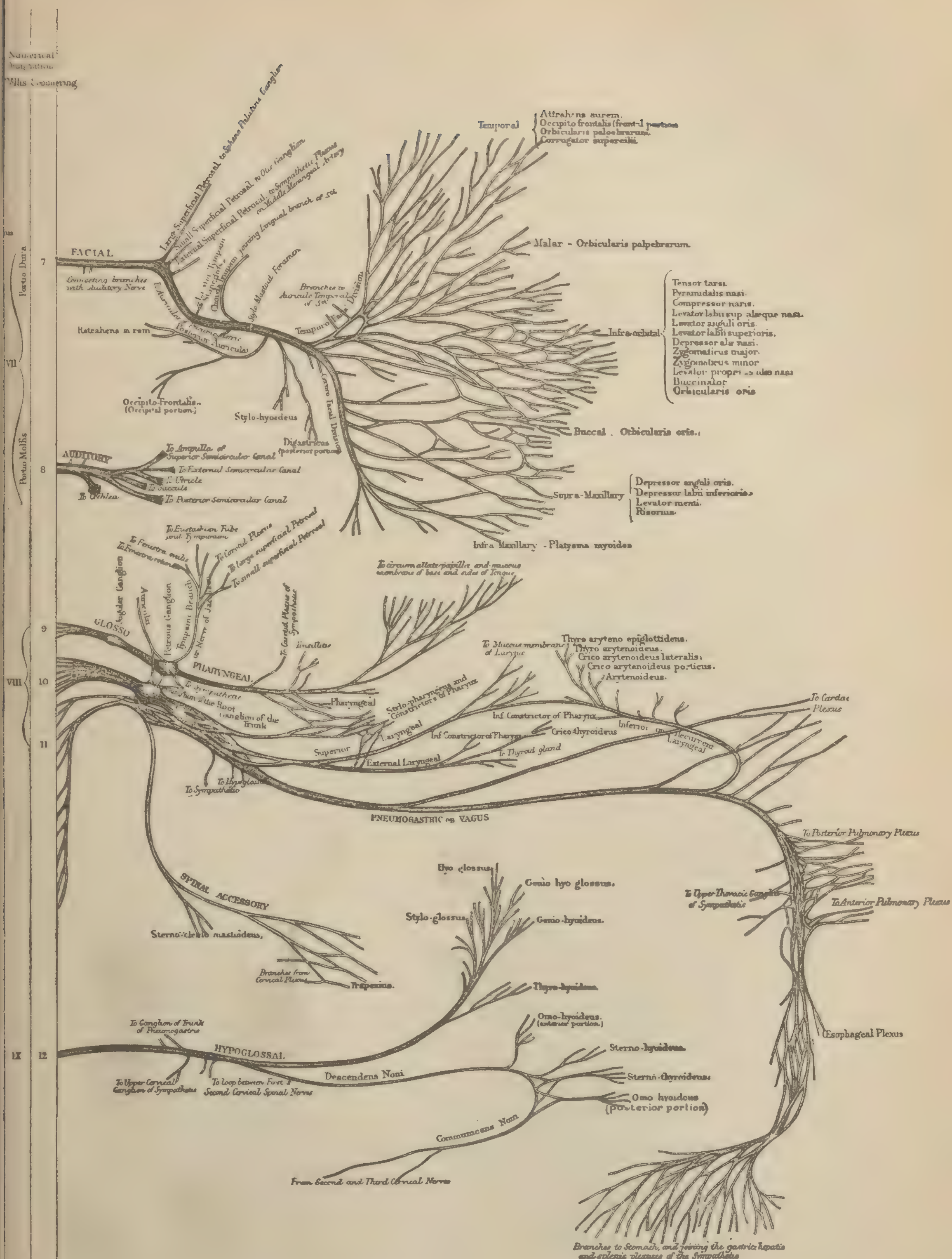


DIAGRAM OF THE LAST SIX CRANIAL NERVES, WITH THEIR CHIEF BRANCHES OF DISTRIBUTION.

7th, Facial (or portio dura [hard part]).
8th, Auditory (or portio mollis [soft part]).
9th, Glosso-pharyngeal.
10th, Pneumogastric (or par vagum, or simply the vagus).
11th, Spinal Accessory; and,
12th, Hypo-glossal.

The 7th and 8th (facial and auditory) make up the 7th pair of Gray, and the 9th, 10th, and 11th (glosso-pharyngeal, pneumogastric, and spinal accessory) make up the 8th pair of Gray. The 12th (hypo-glossal) is the 9th of Gray. Gray's enumeration is destitute of scientific basis; since the only reason for its use renders it incomplete. He includes the 7th and 8th in one pair because they leave the cranium together, or through the same opening at the base of the skull (the internal ear-passage). For a similar reason he considers the 9th, 10th, and 11th as one pair. These pass out together through the jugular foramen (foramen lacerum posterius). But to be consistent, he must also reckon as one pair the 3d, 4th, 6th, and part of the 5th, for these all pass out through the sphenoidal fissure (foramen lacerum anterius); and he must also split up the 1st into numerous pairs, because it leaves the cranium through numerous foramina in the cribriform (sieve-like) plate of the ethmoid bone.

PLACES OF EXIT.

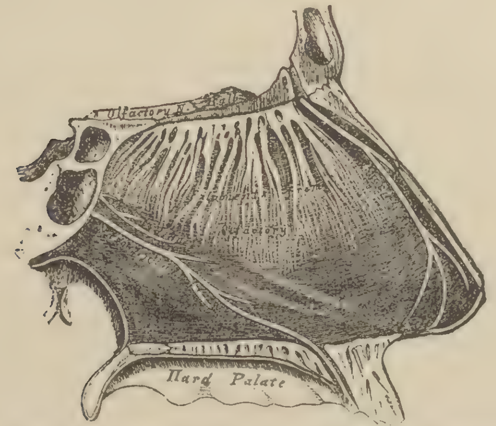
The cranial nerves leave the cranium as follows: the olfactory nerve splits up into numerous filaments as it lies upon the cribriform plate, through which it passes by numerous foramina (openings) to enter the nasal cavities; the optic nerve, on either side, passes through the optic foramen of the sphenoid bone; the motor oculi (mover of the eye), the pathetic, the abducens (leading from; it turns the eye outward), and the ophthalmic branch of the trifacial, all pass through the sphenoidal fissure (the "foramen lacerum anterius" of Gray) into the orbit; the superior maxillary (second division of the trifacial) passes through the foramen rotundum (round opening) of the sphenoid on either side; the inferior maxillary nerve (third division of the trifacial) passes through the foramen ovale (oval opening) of the sphenoid; the facial and auditory nerves both enter the meatus auditorius internus (internal ear-passage); the glosso-pharyngeal, pneumogastric, and spinal accessory leave the cavity of the skull through the jugular foramen (foramen lacerum posterius: the jugular foramen lies in the junction of the occipital bone with the petrous portion of the

temporal) in connection with the internal jugular vein; and, lastly, the hypo-glossal nerve passes through the anterior condyloid foramen (or foramina, as this foramen is sometimes double) of the occipital bone.

OFFICE OF THE CRANIAL NERVES.

The "**olfactory**" (smell-causing) is a nerve of "special sense," and is distributed to the mucous membrane (schneiderian, or pituitary membrane) of the two upper passages (meatuses) of the nose.

Fig. 213.



OLFACTORY AND ANTERIOR PALATINE NERVES UPON THE SEPTUM OF THE NOSE.

The "**optic**" (seeing) supplies the retina of the eye, and is the nerve of vision, or sight. Paralysis (diminution, or loss of power or function) of this nerve is called "amaurosis" (obscuration, or darkening), or, when slight, "gutta serena" ("clear drop"—when floating specks are seen).

The **motor oculi** (mover of the eye), or motores oculorum (plural of motor oculi), is a *nerve of motion*, and supplies five of the seven orbital muscles, and sends motor filaments to the iris (colored portion of the eye around the pupil).

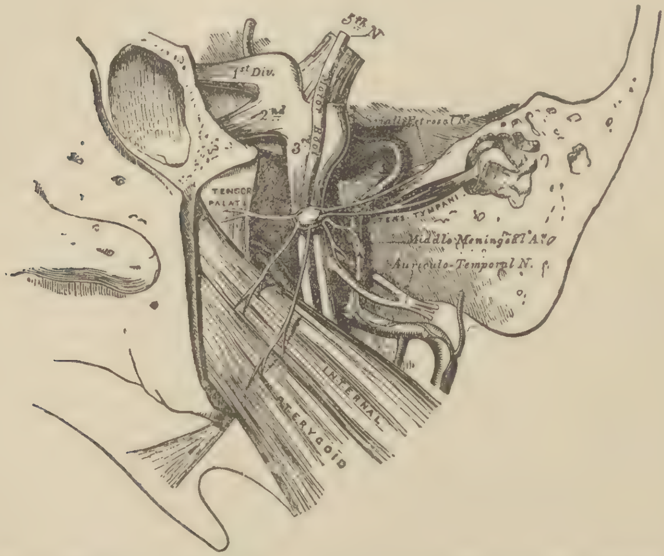
The **pathetic** (or *trochlear*) is a nerve of motion, and supplies the superior oblique muscle of the eye.

The **trifacial,** or **trigemini** (three twins), divides into three portions,—the ophthalmic, superior, and inferior maxillary. The first and second portions, or branches, are sensory; the third (the inferior maxillary) is both sensory and motor. The first branch (ophthalmic) supplies the conjunctiva (a delicate membrane that covers the eye in

front and lines the lids), the lachrymal (tear) gland, and some other parts about the eye. The second branch (superior maxillary) supplies the upper teeth and the facial muscles of the superior maxillary region with sensation. The third branch, or portion of the trifacial (the inferior maxillary), supplies the muscles of mastication with motor power; and the lower teeth, tongue, and lower parts of the face with sensation.

The trifacial, or trigemini, is often called the fifth pair. It is the most difficult to trace of all the cranial nerves.

Fig. 214.



OTIC (ARNOLD'S) GANGLION, AND ITS BRANCHES TO THE TENSOR TYMPANI AND TENSOR PALATI MUSCLES.

These three branches of the trifacial (three-faced, or thrice facial) make their exit from the bones of the face through three foramina (the supraorbital, infraorbital, and mental) that **form a vertical line** upon the face. This line runs in front of the eye and near the angle of the mouth. The supraorbital foramen is sometimes a notch, or groove, only, in the frontal bone above the orbit.

The **abducens** (leading from) is a motor nerve, and supplies the external rectus muscle of the eyeball.

The **facial nerves** (do not confound these with the trifacial), one on each side of the face, are nerves of motion, and supply nearly all the muscles of expression (thirty pairs and one single muscle).

The **auditory nerve** is the nerve of hearing (one of the special senses), and supplies the internal ear (the labyrinth).

The **glosso-pharyngeal** (tongue and throat) supplies the tongue and throat. It is in part a nerve of special sense (sense of taste), and in part a nerve of sensation. The **pneumogastric** and **spinal accessory** are "mixed nerves" (motor and sensory).

The **pneumogastric** (lung and stomach nerve) supplies the organs of voice and respiration with motor and sensory fibers; and the pharynx, œsophagus, stomach, and heart with motor influence. It has a more extensive distribution than any other cranial nerve, passing down the neck through the chest and diaphragm into the abdomen. It is often called the "**vagus**" (wanderer), or **par vagum** (wandering pair).

The "**spinal accessory**" nerve consists of two parts: one, accessory to the pneumogastric, supplies branches to the pharynx and larynx; the other, the spinal portion, supplies the trapezius and sterno-cleido-mastoid muscles, and sends some branches to the cervical (upper spinal) nerves. The two portions have separate origins—one (the accessory portion) within, and the other (the spinal portion) without the cavity of the cranium. The spinal portion of this nerve arises from the lateral (or antero-lateral) tract, or column of the spinal cord, as low as the sixth cervical nerve; and *ascending*, enters the cranium through the foramen magnum, to unite with the other (accessory) portion, and pass out of the cranium with it, through the jugular foramen, in the same sheath as the pneumogastric.

The **hypo-glossal** (under the tongue) is a nerve of motion, and supplies the muscles of the tongue.

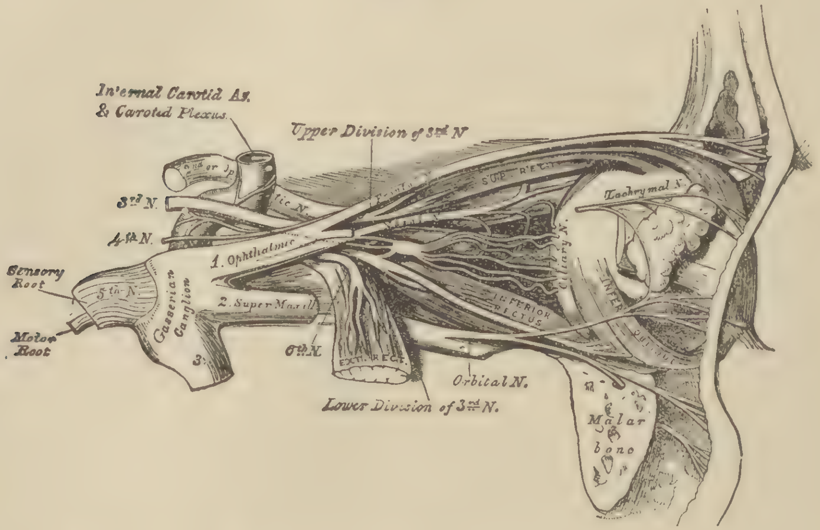
All the cranial nerves make their exit through openings in the base of the skull, and all, except the spinal portion of the spinal accessory, arise from the encephalon (within the head).

The trunk and bulb of the olfactory nerve are really part of the encephalon, having no sheath. It sends twenty branches to the mucous membrane of the nose.

The optic (seeing) nerves of the two opposite sides run obliquely backward and inward from the posterior part of the eyeballs till they meet at the optic commissure, immediately above the body of the sphenoid bone, at the base of the cerebrum. At the commissure (junction) of the optic nerves, some of the fibers turn back toward the other eye; some cross to the other side of the brain, and continue along the optic tracts to their origin in the corpora quadrigemina; some pass from one optic tract to the other; and others are continued into the optic tract of the same side.

The trifacial (fifth pair) resembles the spinal nerves, in having a sensory root with a ganglion upon it, the "Gasserian, or semilunar." The trifacial first appears at the under surface of the brain, at the side of the "pons Varolii," where it consists of two fasciculi (small bundles) — an anterior and a posterior root. Like the spinal nerves, the anterior root is motor, the posterior, sensory. The anterior root has about twenty filaments; the posterior, from seventy to one hundred.

Fig. 215.



NERVES OF THE ORBIT AND OPHTHALMIC, OR CILIARY GANGLION.

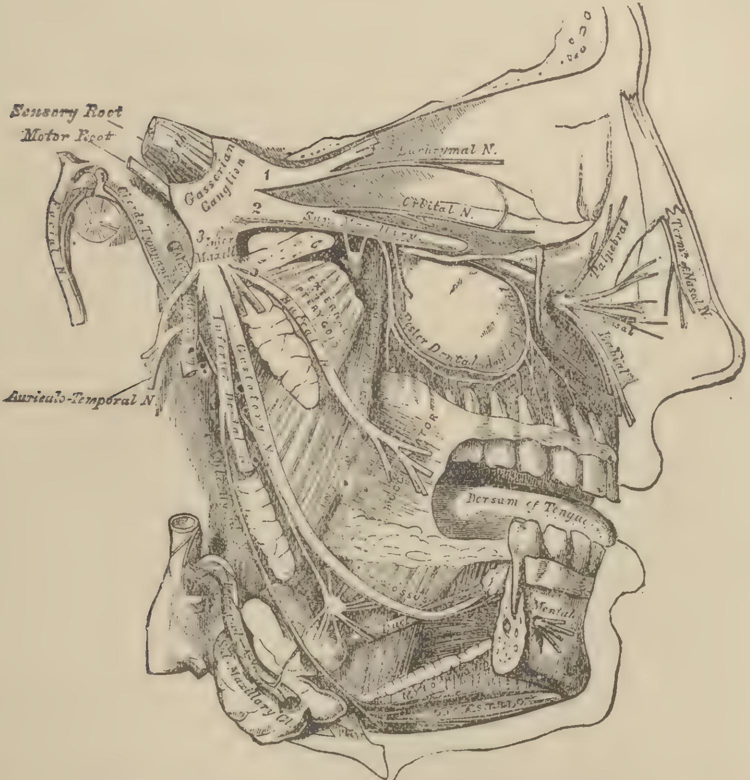
The latter is seen at the central part of the figure, and gives off the short ciliary nerves to the ciliary muscle and iris.

The ganglion ("Gasserian") is on the posterior root, near the apex of the petrous portion of the temporal bone. From the anterior border of the ganglion are given off the three branches of the fifth pair; viz., the ophthalmic, superior, and inferior maxillary nerves. The anterior root is not connected with the ganglion, but passes beneath it and through the oval foramen of the sphenoid to unite with the inferior maxillary, and give it motor influence. Both roots originate in the gray matter of the medulla oblongata.

The **ophthalmic** branch from the ganglion and posterior root, passes forward through the sphenoidal fissure into the orbit, and divides into the **lachrymal, frontal,** and **nasal** branches. The lachrymal (tear) supplies the gland and conjunctiva; the frontal, the forehead and eyelids; and the nasal, the ciliary muscle and iris, the

septum and tip of the nose, and the ciliary ganglion. The "frontal" branch of the ophthalmic divides within the orbit into the supratrochlear and supraorbital branches. The "supraorbital" branch of the frontal is the direct continuation of the ophthalmic division of the fifth pair, and is the nerve that emerges upon the face above the eye. The *nasal* (third branch of the ophthalmic) enters the orbit with the other

Fig. 216.



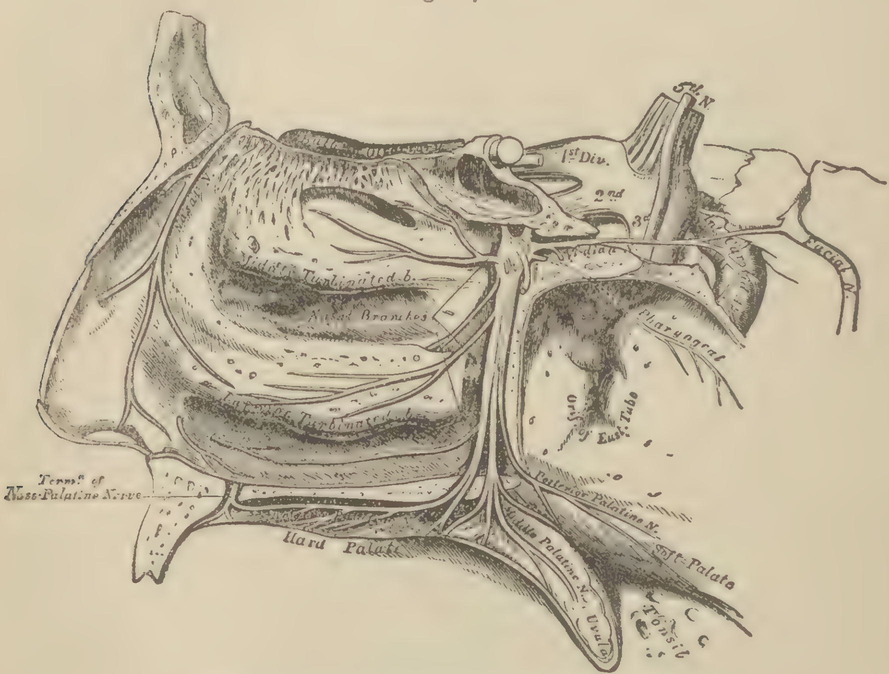
SECOND AND THIRD DIVISIONS OF THE FIFTH CRANIAL NERVE, ITS SENSORY AND MOTOR ROOTS, THE GASSERIAN GANGLION, CHORDA TYMPANI NERVE, AND SUBMAXILLARY GANGLION, ETC.

branches (lachrymal and frontal) of the ophthalmic through the sphenoidal fissure, passes obliquely inward across the optic nerve, then re-enters the cavity of the cranium, and passes down by the side of the crista galli (cock's comb) of the ethmoid into the nose.

The **superior maxillary** (second branch of the fifth cranial) **nerve** extends from the Gasserian ganglion through the foramen rotundum ("round foramen" of the sphenoid bone), across the spheno-maxillary

fossa (a triangular space between the sphenoid and superior maxillary bones), through the infraorbital canal just beneath the floor of the orbit, and appears upon the face below the eye, where it divides into its terminal branches (the **palpebral, nasal**, and **labial**). While in the infraorbital canal it gives off the **anterior dental nerve**, which enters a special canal (the anterior dental) within the upper jaw, and supplies some of the front teeth (incisors, canine, and first bicuspid). In the spheno-maxillary fossa, the superior maxillary nerve gives off

Fig. 217.



SPHENO-PALATINE GANGLION AND ITS BRANCHES.
Spheno-palatine, near the sphenoid and palate bones.

five branches (one orbital, two spheno-palatine, and **two posterior dental**). The orbital enters the orbit, and divides into two branches (temporal and malar). The spheno-palatine branches descend to the the ganglion of the same name. The **posterior dental** branches enter the substance of the upper jaw, and supply the upper molar and bicuspid teeth, the gums, and the buccinator muscle. The palpebral branches of the superior maxillary nerve supply the orbicularis palpebrarum (round of the lids), and the integument and conjunctiva of the lower lid. The nasal branches supply the muscles and integument of

the side of the nose. The labial (lip) branches supply the integument and muscles of the upper lip and the mucous membrane of the mouth.

The **inferior maxillary nerve** is the largest of the three divisions of the fifth cranial. It leaves the cranium through the oval foramen (foramen ovale), unites with the smaller (anterior) root of the fifth pair, and immediately beneath the base of the skull divides into two trunks (anterior and posterior). The anterior trunk gives off four branches — the masseteric, deep temporal, buccal, and pterygoid; and the posterior trunk three branches,— the auriculo-temporal, gustatory, and inferior

Fig. 218.

BRANCHES OF THE INFERIOR MAXILLARY NERVE, AND THE CHORDA TYMPANI, IN CONNECTION WITH THE FACIAL NERVE.

dental. The branches from the anterior trunk supply the muscles which give them name,— the masseter, temporal, buccinator, and pterygoid muscles. The auriculo-temporal branch divides into the auricular (ear) and temporal branches.

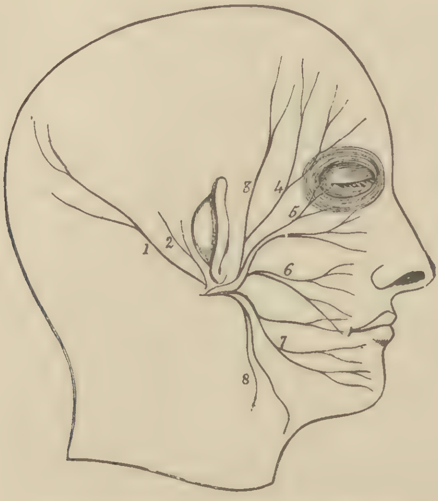
The **gustatory** ("taste," or lingual) **nerve** supplies the papillæ and mucous membrane of the tongue, and the sublingual gland.

The **inferior dental** is the largest branch of the inferior maxillary nerve. It descends from the posterior trunk of that nerve, with the inferior dental artery to the inferior dental foramen, where it gives off a branch (the mylo-hyoid) to the mylo-hyoid and digastric muscles;

passes forward in the dental canal, beneath the teeth, giving off dental branches to the lower molar and bicuspid teeth, till it reaches the mental foramen, where it divides into two branches (mental and incisor). The mental branch emerges from the mental foramen, upon the face, and the *incisor* branch continues onward within the bone to the median line, and supplies the lower incisor teeth. The mental branch supplies the depressor anguli oris, the orbicularis oris, and the quadratus menti (or depressor labii inferioris) muscles, and the integument of the lower lip.

The **facial nerve** supplies not only the muscles of expression, but also the following: the platysma, buccinator, stylo-hyoid, posterior belly

Fig. 219.



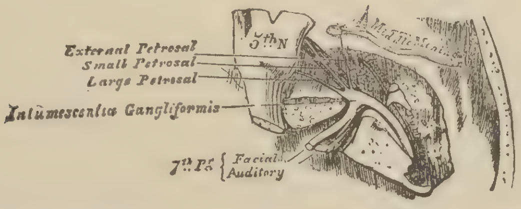
BRANCHES OF THE FACIAL NERVE.

1. Branch of the Occipito-frontalis Muscle.
2. Posterior Auricular.
3. Temporal.
4. Malar.
5. Infra-orbital.
6. Buccal.
7. Supramaxillary.
8. Inframaxillary.

of the digastric, and the muscles of the tympanum, and auricle. It arises from the medulla oblongata, leaves the cavity of the cranium through the internal ear-passage (meatus auditorius internus), in connection with the auditory nerve, enters the aqueduct of Fallopius (Gabriel Fallopius) at the bottom of the meatus, follows the curved course of that canal through the petrous portion of the temporal bone, and emerges at the stylo-mastoid foramen (opening between the styloid and mastoid processes) in the substance of the parotid gland, crosses the external carotid artery, and divides behind the ramus of the lower jaw into two branches (temporo-facial and cervico-facial), which send numerous branches over the side of the head, face, and upper part of the neck.

Besides the two terminal branches, the facial nerve has four or five other branches,—three given off at its exit from the stylo-mastoid foramen (the stylo-hyoid, digastric, and posterior auricular branches), and one or two within the aqueductus Fallopii (the tympanic, and, according to several authors, the *chorda tympani*). The **chorda tympani** is, however, of doubtful origin. Some authors consider it a branch of the fifth pair (trifacial). It leaves the facial nerve at an acute angle, ascends in a distinct canal to the tympanum, passes forward through that cavity to its anterior inferior angle, and entering the canal of Huguier at the inner and upper side of the Eustachian canal, emerges from the bone at the inner side of the Glasserian fissure; descends between the two pterygoid muscles, meets the gustatory nerve (branch of the fifth pair) at an acute angle, accompanies it to the submaxillary gland, which it supplies, and then joins the submaxillary ganglion. Gray

Fig. 220.



COURSE AND CONNECTIONS OF THE FACIAL NERVE IN THE TEMPORAL BONE.

tells us that this nerve terminates in the lingualis muscle, and some other authors say it is distributed to the mucous membrane of the anterior two thirds of the tongue, and governs the sense of taste; but considering the fact that the facial nerve is a nerve of motion, and also that the chorda tympani meets both the facial and gustatory nerves at an angle which militates against the theory of its cranial origin, we are led to believe that the chorda tympani is *not* a branch of the seventh (facial) pair, nor of the fifth, but is a **sympathetic nerve**, arising from the submaxillary ganglion, running for a short distance with the gustatory nerve, supplying the submaxillary gland, and then joining the facial nerve to be distributed upon the face.

The trifacial and glosso-pharyngeal nerves preside over the sense of taste.

The *tympanic* branch of the facial supplies the stapedius and laxator tympani muscles — both muscles of the tympanum.

The *temporo-facial* branch is the larger of the two terminal branches of the facial. It passes upward and forward through the parotid gland; crosses the neck of the condyle of the jaw, and divides into branches, which are distributed to the temple and upper part of the face.

The cervico-facial (neck and face) branch passes downward and forward through the parotid gland, and opposite the angle of the lower jaw, divides into branches to the lower half of the face and upper part of the neck.

The **auditory nerve** divides at the bottom of the internal ear-passage into two branches, cochlear and vestibular, which are distributed, one to the cochlea, the other to the vestibule and semicircular canals of the internal ear (labyrinth).

The **glosso-pharyngeal nerve** gives off six branches, or sets of branches: the tympanic (called, also, Jacobson's), carotid branches, pharyngeal, muscular, tonsilar, and lingual. The tympanic branch supplies the membrane of the tympanum and Eustachian tube. The carotid branches descend along the internal carotid artery. The pharyngeal branches help to form the pharyngeal plexus, which supplies the mucous membrane of the throat. The muscular branches supply the stylo-pharyngeus muscle. The tonsilar branches form a plexus around the tonsil, and send branches to the soft palate and fauces (entrance to the throat). The lingual branches, two in number, are sent to the tongue. The glosso-pharyngeal nerve has two ganglionic enlargements within the jugular foramen, which are designated as superior and inferior, or the jugular and the petrous ganglion.

The *pneumogastric* is one of the most important of all the cranial nerves. It gives off nine sets of branches, as follows: in the jugular fossa it gives off the auricular (Arnold's nerve) to the integument of the auricle (pinna, pavilion, or external ear); in the neck it gives off the pharyngeal to the pharyngeal plexus; the *superior laryngeal* (to the larynx), which is a nerve of sensation; the *recurrent laryngeal* (so called from its reflected course), which supplies the muscles of phonation (use of the voice); the cardiac branches (one in the neck and one in the thorax — cervical and thoracic), which help to form the cardiac (heart) plexus; in the thorax it gives off the pulmonary branches to the anterior and posterior pulmonary plexus; the œsophageal to the œsophageal plexus; and in the abdomen the gastric branches, which send terminal branches to the stomach, spleen, and liver. The gastric branches may be traced to the cœliac, splenic, and hepatic plexuses. The pneumogastric has also two ganglionic enlargements; one while within the jugular foramen (called the "jugular ganglion of the pneumogastric"), and the other after the exit of the nerve from the foramen (called the "inferior ganglion," or "ganglion of the trunk" of the nerve). These ganglia are connected with the sympathetic system. The two pneumogastric nerves descend the neck, one on either side, within the sheath of the carotid arteries (both

internal and common), lying between the internal jugular vein and the carotid artery (the *internal* carotid in the *upper* part of the neck, and the *common* carotid in the *lower* part). Below the root of the neck the course of the two nerves differs. The right pneumogastric passes down between the subclavian vessels (artery and vein), by the side of the trachea (windpipe), to the posterior pulmonary plexus, at the back part of the root of the lung; from this pulmonary plexus two cords descend upon the œsophagus, which help to form the œsophageal plexus, below which a single cord runs along the *back part of the œsophagus* to the cœliac and splenic plexuses in the abdomen. The left pneumogastric enters the chest between the carotid and subclavian arteries (on this side the subclavian artery extends to the arch of the aorta), crosses the arch of the aorta, and descends along the *anterior surface of the œsophagus* to the stomach and left hepatic plexus.

The **spinal accessory nerve** consists of two parts — the accessory and spinal portions. The accessory portion unites with the vagus (pneumogastric) by one or two filaments in the jugular foramen, but its main part unites with the vagus below the second ganglion. It gives branches to the pharyngeal, and superior laryngeal branches of the pneumogastric. The spinal portion of the spinal accessory arises from the spinal cord (by several filaments as low down as the sixth cervical nerve), ascends through the foramen magnum (great opening) of the occipital bone, and passes outward to the jugular foramen, through which it escapes from the cranium in the same sheath with the pneumogastric, but separated from it by a fold of the arachnoid membrane. It assists in the formation of the cervical plexus, and sends branches to the sterno-cleido-mastoid and trapezius muscles.

The **hypo-glossal** (under the tongue) **nerve** gives off the descendens noni (descending of the ninth) and several muscular branches. The descendens noni is given off near the angle of the jaw, and is occasionally contained in the sheath of the carotid vessels. It is a long, slender branch, and supplies the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles. The lingual branch of the hypo-glossal is the continuation of the principal trunk, and gives off numerous filaments to the muscles of the tongue and pharynx (throat).

ORIGIN OF THE CRANIAL NERVES.

The cranial nerves may all be traced to some part of the surface of the base of the brain, where they have their *superficial*, or **apparent origin**; but their **real, or deep origin** is traced into the substance of the brain itself. The gray matter of the brain and upper spinal cord is

probably the real origin of all the cranial nerves. It is found in all the various ganglia of the brain, and interspersed between the white fibrous matter.

The apparent origin of the olfactory nerves, is the olfactory bulbs that lie upon the cribriform plate of the ethmoid bone; but the real origin extends into the anterior and middle lobes of the cerebrum (upper brain).

The apparent origin of the optic nerves is the optic tracts; but these are traced to the corpora quadrigemina (four twin bodies), or optic lobes, which communicate with both the cerebrum and cerebellum (upper and back brains).

The apparent, or superficial orgin of the motor oculi nerve is the crus cerebri (leg of the cerebrum), but its deep origin is traced across the pons Varolii (bridge of Varolius) to the corpora quadrigemina.

The pathetic (trochlear) nerve arises from the valve of Vieussens (Veeur-sonsse), which is a thin plate of nervous matter above the fourth ventricle.

The trifacial (fifth pair) has its superficial origin in the side of the pons Varolii, by two roots which are separated from each other by a few of the transverse fibers of the pons (bridge), but the deep origin is traced into the cerebellum and the medulla oblongata.

The abducens (sixth pair) has its superficial origin by several filaments from the lower border of the pons, but its deep origin is traced to the posterior part of the medulla oblongata.

The facial nerve arises from the medulla between the olivary and restiform bodies; and its fibers are traced to the same nucleus in the medulla as the sixth nerve (abducens).

The auditory nerve has its superficial origin in the transverse lines of the harp ("lyra"), but its deep origin lies in the medulla and cerebellum.

The glosso-pharyngeal nerve arises from the upper part of the medulla, and has its deep origin in a nucleus of gray matter in the floor of the fourth ventricle.

The pneumogastric arises superficially from the side of the medulla (in the "lateral tract," or column), and is traced to the same nucleus with the glosso-pharyngeal.

The spinal accessory arises from the lateral tract of the medulla and spinal cord, having its deep origin in the gray matter, or ganglionic center of the cord.

The hypo-glossal arises by ten or fifteen filaments from a groove between the olivary and pyramidal bodies of the medulla. The filaments are traced to a gray nucleus in the floor of the medulla.

THE SPINAL NERVES.

The spinal nerves have their superficial origin in the spinal cord, and are transmitted through the intervertebral foramina (formed by the intervertebral notches of the vertebræ) of the spinal column. There are usually thirty pairs of spinal nerves arranged in four groups corresponding to the region of the spinal column, in which they seem to originate. The four groups are the cervical, dorsal, lumbar, and sacral. The first pair is the suboccipital, which is included among the cervical. With this addition to the cervical, the number in each group corresponds to the number of vertebræ in each region, giving eight cervical, twelve dorsal, five lumbar, and five sacral.

Fig. 221.

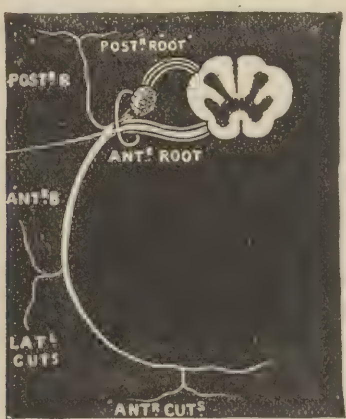


DIAGRAM OF A SPINAL NERVE, SHOWING THE ANTERIOR AND POSTERIOR ROOTS, ANTERIOR AND POSTERIOR BRANCHES, AND THE LATERAL AND ANTERIOR CUTANEOUS BRANCHES.

Each spinal nerve is connected to the cord by two roots,—an anterior, or motor root, and a posterior, or sensory root. The anterior roots arise from the antero-lateral columns of the spinal cord, and the posterior roots from the posterior columns of the cord. If we reckon an anterior *and* a lateral column of the cord, then the anterior roots of the spinal nerves arise from a lineal series of foramina, which seem to divide the anterior and lateral columns of the cord. The two roots of each spinal nerve pierce the dura mater (the outer covering of the cord), and enter the intervertebral foramen of the spinal column. Within the foramen, upon each posterior root, with sometimes the exception of the first cervical nerve, is found a ganglion. Beyond the ganglion the two

Fig. 222.

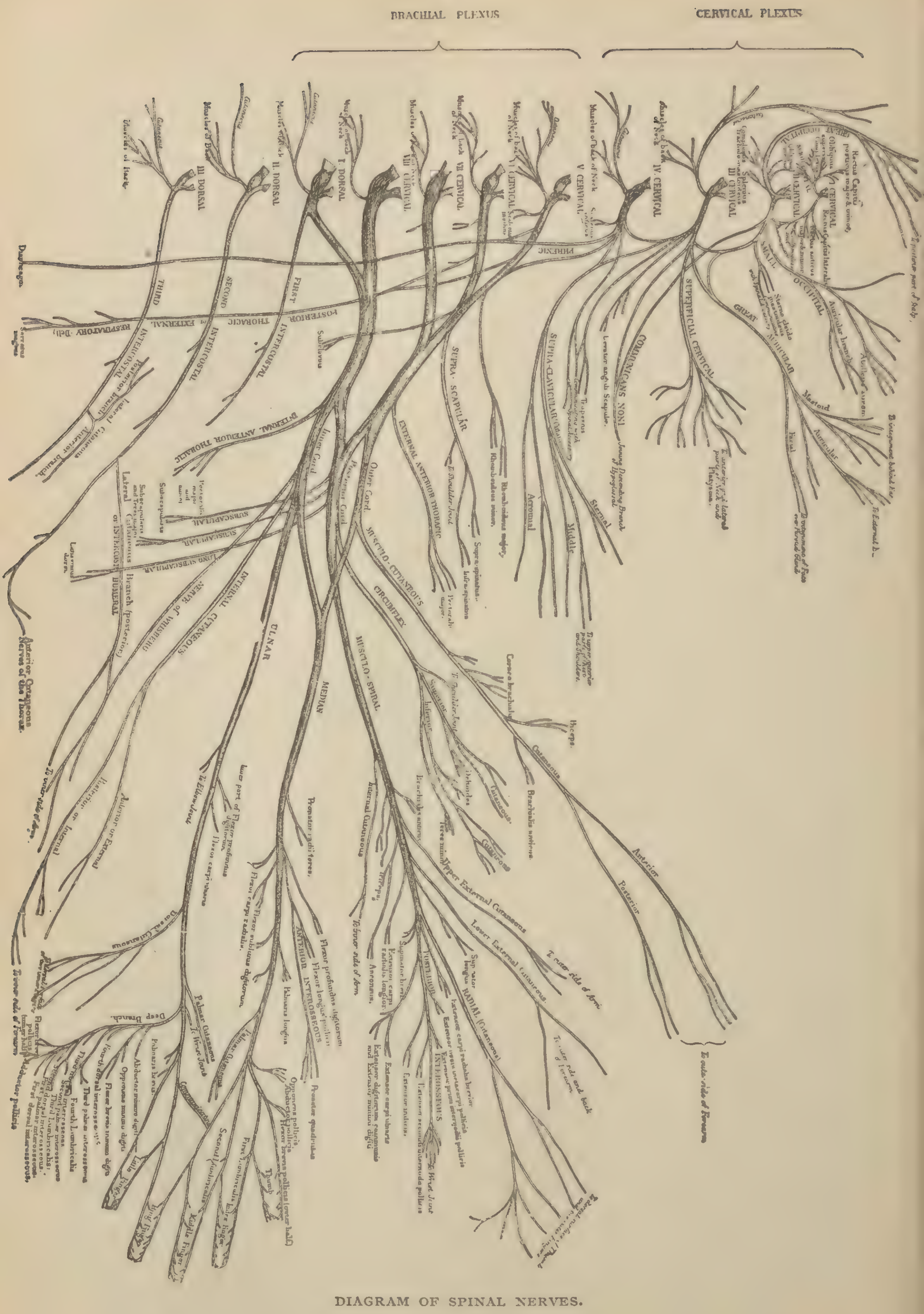


DIAGRAM OF SPINAL NERVES.

Fig. 223.

DIAGRAM OF SPINAL NERVES.

roots coalesce, and the common trunk passes out of the intervertebral, (between the vertebræ) foramen, and divides into an anterior branch for the anterior part of the body, and a posterior branch for the back part. Each branch contains fibers from both roots.

In the cervical, lumbar, and sacral regions the anterior branches of the spinal nerves form intricate plexuses previous to their distribution; but in the dorsal region the anterior branches are separate from each other, and take the name of intercostal branches. The posterior branches supply muscles and integument behind the spinal column. The anterior branches of the first four cervical nerves form the **cervical plexus**, which lies in front of the four upper vertebræ, and is covered, on either side, by the sterno-cleido-mastoid muscle. The branches from the cervical plexus are divided into two groups,—superficial and deep; and the superficial are again divided into the ascending and descending. The three ascending branches are the superficial of the neck (superficialis colli), the great of the auricle (auricularis magnus), and the small occipital (occipitalis minor). The only descending branch of the superficial group of the cervical plexus is the supraclavicular (above the clavicle), which divides into the sternal, clavicular, and acromial. These branches supply the integument of these regions. The deep branches of the cervical plexus are divided into internal and external branches. The internal are the communicating, muscular, communicans noni (communicating of the ninth), and the phrenic.

The **communicating branches** communicate with the pneumogastric, hypo-glossal, and sympathetic nerves. The *muscular* branches supply the anterior recti, and lateral rectus muscles of the neck.

The **communicans noni** forms a loop with the descendens noni (descending of the ninth) of the hypo-glossal in front of the sheath of the carotid vessels.

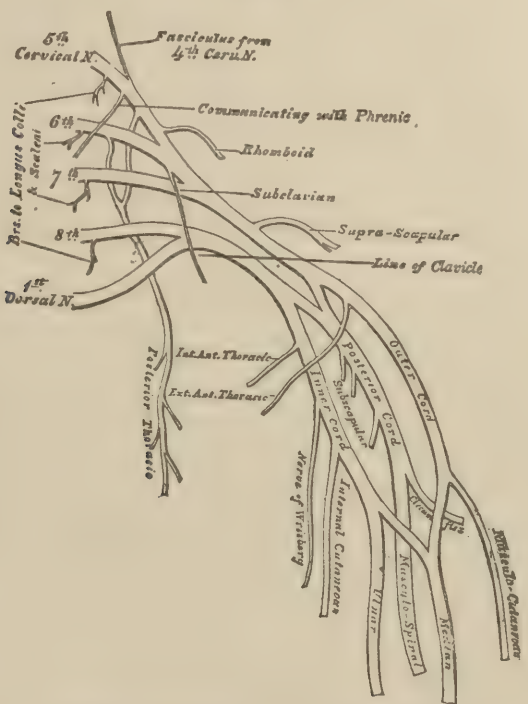
The **phrenic nerve** is the *internal respiratory* of Bell. It descends the neck, enters the chest between the subclavian vessels (artery and vein), crosses the internal mammary artery, and passes down through the diaphragm to supply its under surface. It also sends filaments to the pericardium and pleura. The right phrenic nerve is situated more deeply than the left.

The external branches of the deep group from the cervical plexus are the communicating and the muscular. The communicating join the spinal accessory nerve. The muscular branches are distributed to the sterno-mastoid, levator anguli scapulæ, middle scalene, and trapezius muscles.

The anterior branches of the *four lower cervical and first dorsal* nerves form the **brachial plexus.** The brachial plexus extends from

the lower part of the side of the neck into the axilla (armpit). The five anterior branches of spinal nerves, which form it at first, unite and form *two trunks*, which accompany the subclavian artery to the axilla (arm-pit), where they branch, and again unite to form *three trunks*, or cords (outer, inner, and posterior), which give off the terminal branches of the brachial plexus.

Fig. 224.

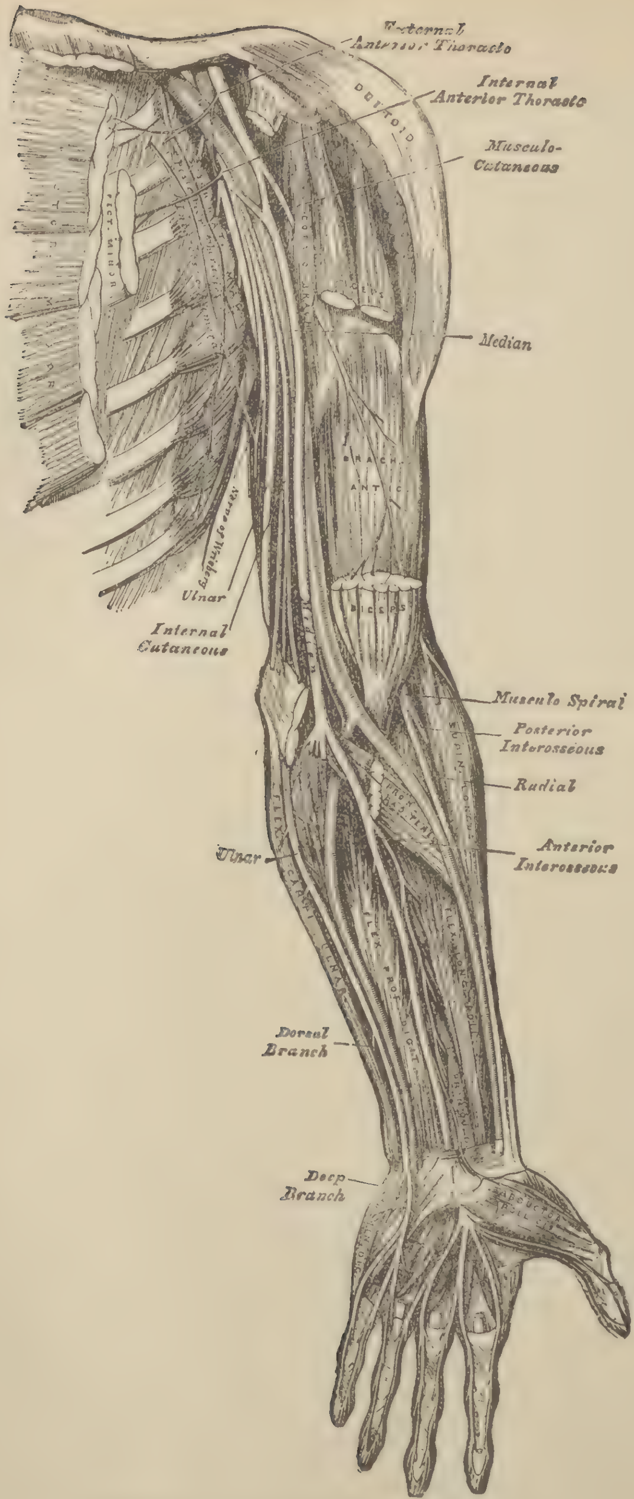


BRACHIAL PLEXUS AND ITS BRANCHES.

The branches are divided into two groups by the position of the clavicle. Those above the clavicle are the communicating, muscular, posterior thoracic, and suprascapular. The **communicating** joins the phrenic which comes from the cervical plexus. The **muscular branches** supply the longus colli, the scalene, rhomboid, and subclavius muscles. The **posterior thoracic** (long thoracic, or *external respiratory* of Bell) supplies the serratus magnus muscle. The **suprascapular** supplies muscles on the back (dorsum) of the scapula (shoulder-blade).

The branches of the brachial plexus, given off below the clavicle, are two **anterior thoracic**, to the pectoral muscles; the **subscapular** (three in number to the subscapularis, teres major, and latissimus dorsi

Fig. 225.



NERVES OF THE LEFT UPPER EXTREMITY.

Fig. 226.

SUPRASCAPULAR, CIRCUMFLEX, AND MUSCULO-SPIRAL NERVES.

muscles) and **circumflex** to the shoulder; and six branches to the arm, forearm, and hand. The latter are three cutaneous (musculo-cutaneous, internal cutaneous, and lesser internal cutaneous),— the median, ulnar, and musculo-spiral.

The **circumflex nerve** sends a filament to the shoulder joint, and supplies some of the muscles, and the integument (skin) of the shoulder.

The **musculo-cutaneous** (called, also, external cutaneous) supplies some of the muscles of the arm — the coraco-brachialis, biceps, and brachialis anticus — and the integument of the forearm.

The **internal cutaneous** is one of the smallest branches of the brachial plexus. It supplies the integument covering the biceps muscle and sends an anterior and posterior branch to the integument of the forearm.

The **lesser internal cutaneous** nerve is the smallest of the branches of the brachial plexus. It is called, also, the *nerve of Wrisberg*. It passes through the axillary space along the inner side of the brachial artery to the skin upon the back part of the arm near the elbow.

The **median nerve** (middle of the arm) arises from the outer and inner cords (or trunks) of the brachial plexus, which unite in front of the axillary artery, passes down the arm and forearm between the ulnar nerve on the inner side and the musculo-spiral and radial nerves on the outer, to the hand, where it gives off digital (finger) branches. In the forearm it gives off the palmar cutaneous, anterior interosseous, and muscular branches. The median gives off no branches above the elbow.

The **ulnar nerve** runs along the ulnar (inner) side of the upper extremity, and is distributed to muscles and integument of the forearm and hand. At the elbow it rests upon the back of the inner condyle, between the inner condyle and olecranon (head of the elbow). The ulnar gives off articular (joint) branches to the elbow and wrist, two muscular branches, a cutaneous and dorsal cutaneous, in the forearm; and, in the hand, a superficial palmar and deep palmar branch.

The **musculo-spiral nerve** is the largest branch of the brachial plexus. It arises from the posterior cord of the brachial plexus in connection with the circumflex nerve, winds round the humerus in the spiral groove with the superior profunda artery and vein, passing from the inner to the outer side of the bone beneath the triceps muscle, and descends to the front of the external condyle, where it divides into the radial and posterior interosseous nerves. It gives off numerous muscular branches and three cutaneous branches.

The **radial nerve** passes along the front of the radial side (the thumb side) of the forearm, a little to the outer side of the radial artery, but leaves the artery about seven centimeters (three inches) above the

Fig. 227.

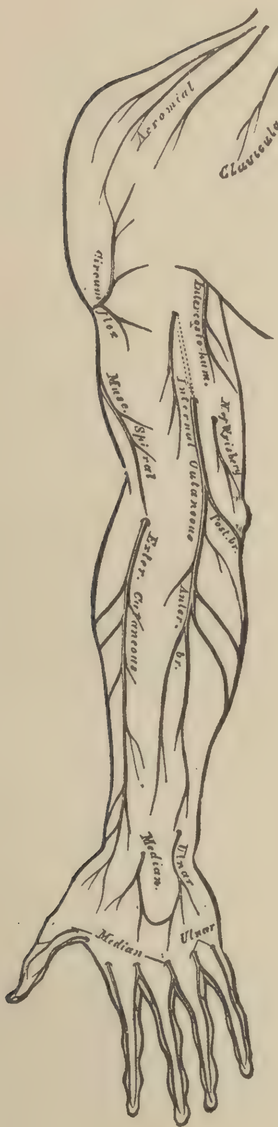
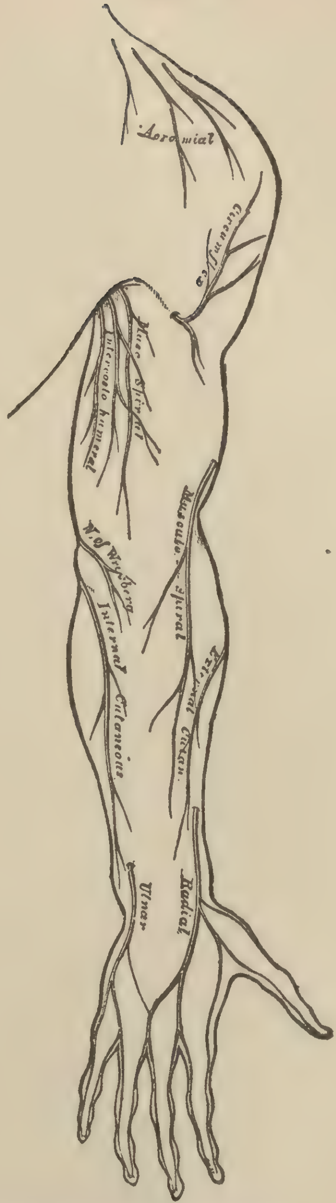


Fig. 228.



CUTANEOUS NERVES OF THE RIGHT UPPER EXTREMITY—ANTERIOR AND POSTERIOR VIEWS.

The **posterior interosseous nerve** supplies muscles of the radial and posterior brachial regions.

The **dorsal nerves** (second group of spinal nerves) are twelve in number on each side. As they emerge from the spinal column they divide into two branches (anterior and posterior). The posterior branches still retain the name of "dorsal," but the anterior branches are called the intercostal nerves. The dorsal branches divide into **external** and **internal branches.** The external supply the longissimus dorsi, sacro-lumbalis, and levatores costarum (lifters of the ribs); and the six lower branches give off cutaneous filaments. The internal branches supply the multifidus spinæ and semi-spinalis dorsi muscles, and the six upper branches give off cutaneous filaments.

The **intercostal branches** (anterior branches of the spinal nerves in the dorsal region) supply the walls (parietes) of the chest (thorax) and abdomen without being joined in plexuses, like other anterior branches of the spinal nerves. Each intercostal nerve is connected with the adjoining ganglia of the sympathetic system.

The branches of the intercostal nerves are the **muscular** and the **cutaneous.** The cutaneous are divided into lateral and anterior branches.

The **lumbar** (loin) **nerves** are five in number on each side. They have the largest roots of all the spinal nerves, and the greatest number of filaments. Their roots come off from the lower end of the cord, and extend vertically downward in the spinal canal, to emerge through the intervertebral foramina (openings between the vertebræ) of the lumbar vertebræ, and divide into anterior and posterior branches. The anterior branches of the four upper lumbar nerves form the lumbar plexus. The anterior branch of the fifth lumbar enters into the formation of the sacral plexus.

The **lumbar plexus** is situated in the substance of the psoas muscle on each side, and in front of the transverse processes of the lumbar vertebræ. The lumbar plexus forms the seven following nerves: the ilio-hypogastric, ilio-inguinal, genito-crural, external cutaneous, obturator, accessory obturator, and the anterior crural. The first two, and part of the third of these seven, supply the lower part of the walls of the abdomen; the rest are distributed to the forepart of the thigh and inner side of the leg.

The **ilio-hypogastric** divides into the iliac and hypogastric nerves.

The **genito crural nerve** divides near Poupart's ligament into a genital and crural branch.

The **genital** branch descends on the external iliac artery, and passes through the inguinal canal with the spermatic cord to the cremaster muscle in the male, and with the round ligament in the female.

Fig. 229.

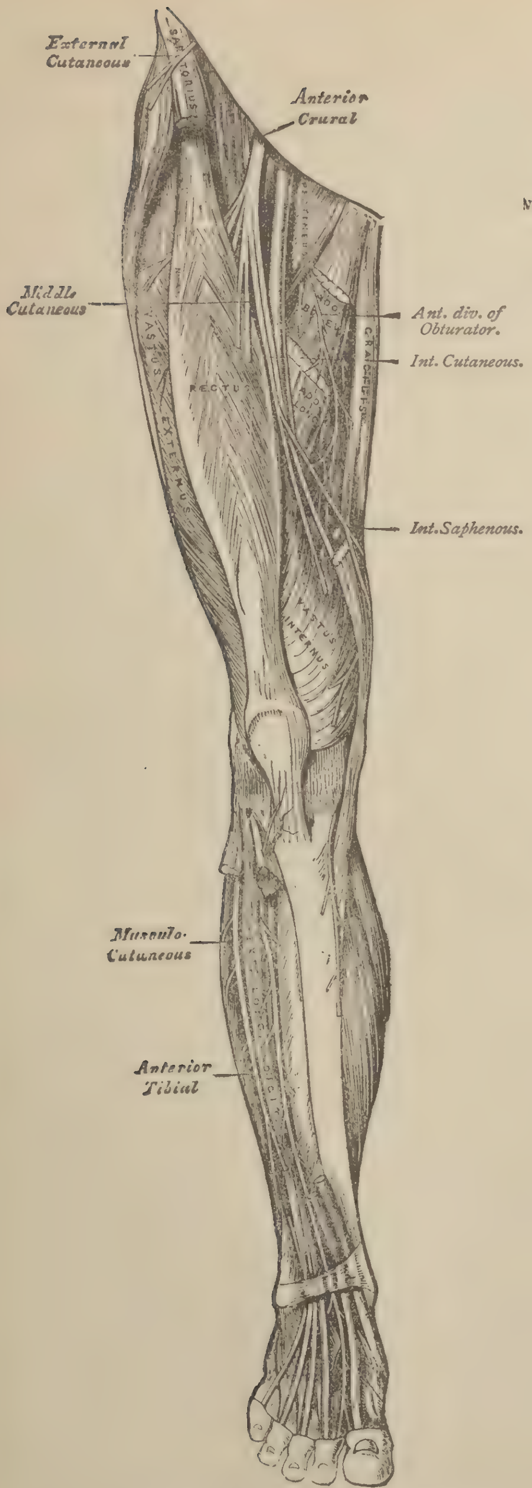
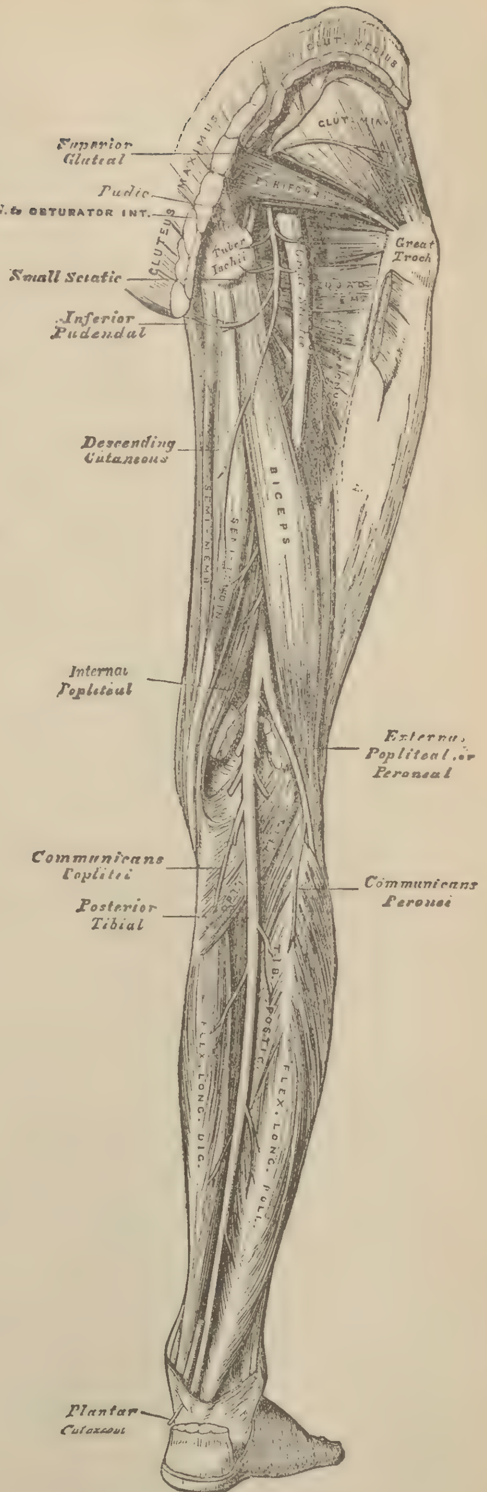


Fig. 230.



NERVES OF THE LOWER EXTREMITY—ANTERIOR AND POSTERIOR VIEWS.

The **crural branch** passes beneath Poupart's ligament to the integument of the upper part of the thigh.

The **obturator nerve** supplies the obturator externus, the adductor muscles of the thigh, and the joints of both the hip and knee; so that hip disease, which affects the obturator nerve, frequently causes pain at the knee.

The **anterior crural** is the largest branch of the lumbar plexus. It passes beneath Poupart's ligament, separated from the femoral artery by the psoas muscle, to supply muscles and integument on the *front and inner side* of the thigh, leg, and foot. Below Poupart's ligament its branches form the long (or **internal**) **saphenous**, the **middle**, and **internal cutaneous**, **articular**, and **muscular branches.** The anterior crural nerve, as a whole, terminates in the thigh, by dividing into the anterior and posterior divisions. The muscular and articular branches form the posterior division of the anterior crural.

The muscular supply the pectineus, and all the muscles on the front of the thigh except two (the sartorius and tensor vaginæ femoris).

The articular branches supply the knee-joint.

The **sacral**, like all other spinal **nerves**, divide into anterior and posterior branches. The anterior branches of the upper three sacral nerves, with a part of the fourth, united with branches from the fourth and fifth lumbar nerves, form the **sacral plexus.** The fifth sacral nerve passes from the lower end of the sacral canal. The sacral plexus is triangular in form, with its apex at the lower part of the great sacro-sciatic foramen (large opening between the sacrum and ischium). The base of this triangle of nerves corresponds to the four anterior sacral foramina, of each side, that transmit sacral nerves. The sacral plexus, one on either side, is within the pelvis.

The branches of the sacral plexus are the muscular, superior, gluteal, pudic, small sciatic, and great sciatic. All except a part of the first leave the pelvis through the great sacro-sciatic foramen.

The **muscular branches** supply the pyriform, the internal obturator, the two gemelli (inferior and superior), and the quadratus femoris.

The **superior gluteal** supplies two of the three gluteal muscles—the middle and small gluteal.

The **pudic nerve** leaves the pelvis through the great sacro-sciatic foramen, crosses the spine of the ischium, and *re-enters the pelvis* through the small sacro-sciatic foramen. It accompanies the pudic vessels, and divides into the perineal nerve and "dorsal of the penis."

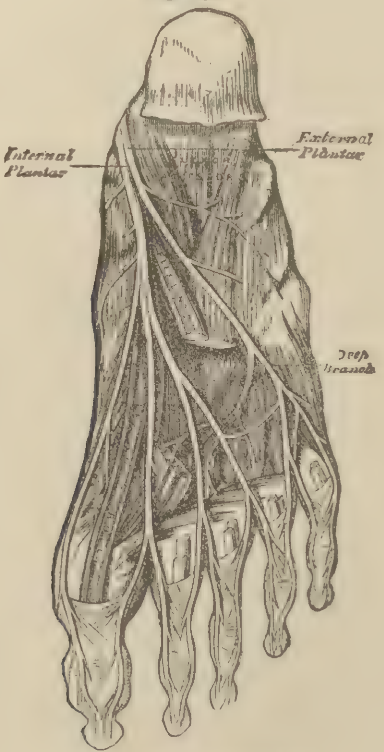
The **small sciatic nerve** supplies one muscle (the gluteus maximus), and the *integument* of other parts (perineum and back part of the thigh and leg).

Fig. 231.

CUTANEOUS NERVES OF THE LOWER EXTREMITY—POSTERIOR VIEW.

The **great sciatic nerve** supplies the greater part of the integument of the leg, and the *muscles* of the back of the thigh, leg, and foot. It is the largest nervous cord in the body, and is the continuation of the lower part of the sacral plexus. It emerges from the pelvis through the great sacro-sciatic foramen, and divides in the thigh, usually below the middle, into the **internal** and **external popliteal** nerves. The internal popliteal nerve passes through the middle of the popliteal space, while the external popliteal passes along the outer side of the same space. The great sciatic descends between the great trochanter of the femur and the tuberosity of the ischium along the back part of the thigh. Besides the internal and external popliteal, it gives off **articular branches** to the hip joint and **muscular branches** to the flexors of the leg.

Fig. 232.



THE PLANTAR NERVES.

The internal popliteal becomes the **posterior tibial**. The latter divides into the **external** and **internal plantar**, which supply the foot.

The principal **nerves that govern respiration** are the pneumogastric, spinal accessory (superior respiratory), phrenic (internal respiratory of Bell), and the posterior, or long thoracic (external respiratory of Bell).

SYMPATHETIC, OR ORGANIC SYSTEM OF NERVES.

The sympathetic nerves were called by Bichat (pronounced Bee-shar) **nerves of organic life**, while the cerebro-spinal nerves were called nerves of animal life. The sympathetic nerves control the circulation of the blood, respiration, nutrition, and all the various vital processes. They are the *involuntary* nerves, not directly under the control of the human will.

The sympathetic system consists of ganglia, plexuses, and nerves. The ganglia (knots) are nerve-centers. These are connected by branches of communication, and with the various organs, vessels, and viscera, by means of nerves which cross each other in an intricate

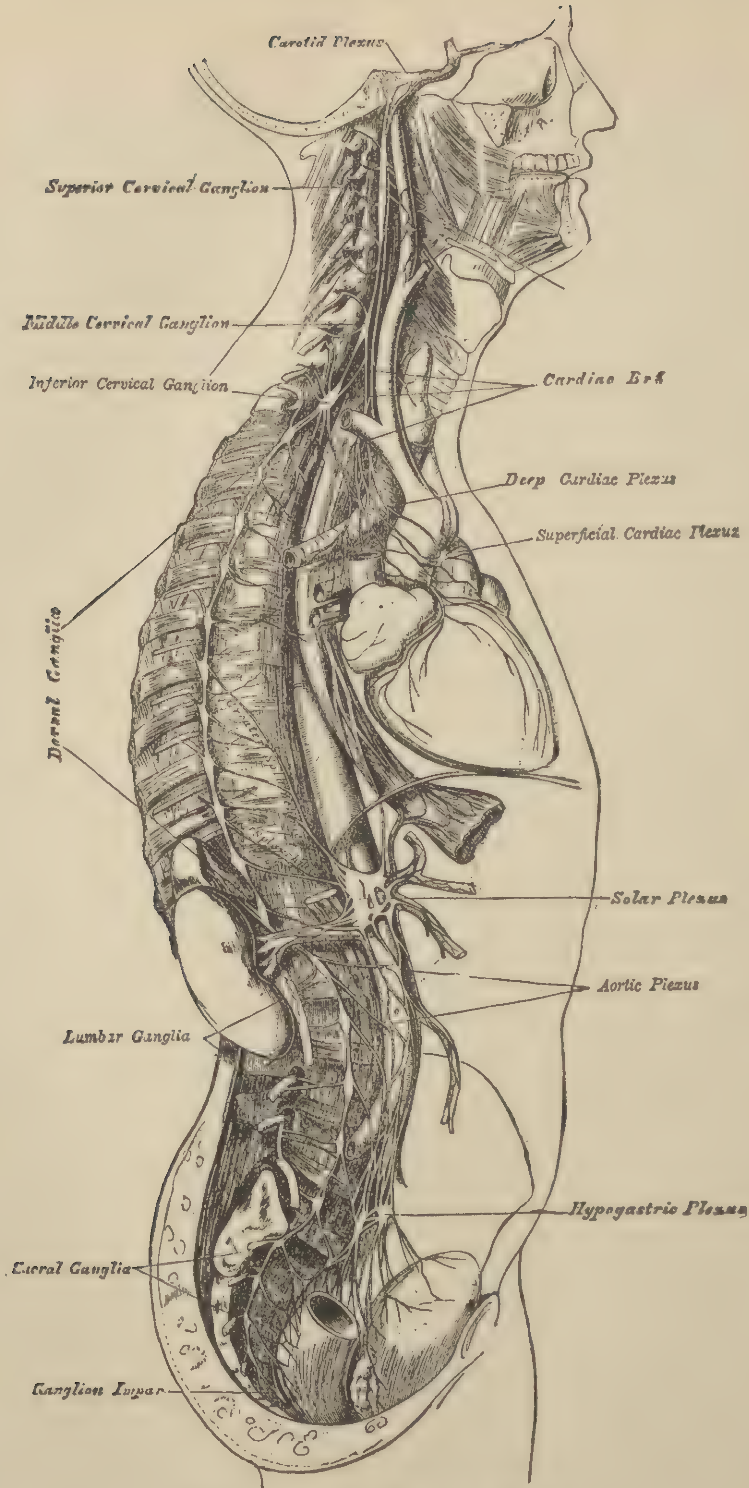
Fig. 233.

NERVE CELLS, OR NERVE-CENTERS.

manner, and form a great number of plexuses (networks). The ganglia, which are *generally* recognized as parts of the sympathetic system, are situated within the great cavities of the head and trunk, on either side of the spinal column, and form a double axis extending from the cranium to the coccyx. They are all connected by branches of communication, and by white nerve-fibers, with the brain and spinal cord. They are named, from their position, cephalic (in the head), cervical (neck), dorsal (back), lumbar (loins), sacral (in front of the sacrum), and coccygeal (situated in front of the coccyx).

The cephalic ganglia may, perhaps, properly include all the numerous *nerve-centers* of the encephalon, or brain; although anatomists usually reckon only four, or, at most, six cephalic ganglia con-

Fig. 234.



SYMPATHETIC GANGLIA AND NERVES.

nected with the sympathetic system. Gray mentions only four. These four are the ophthalmic (or ciliary), spheno-palatine (or Meckel's ganglion), otic (or Arnold's ganglion), and the submaxillary. Other authors add the ganglion of Ribes, situated upon the anterior communicating artery, and the Gasserian, or semilunar ganglion, found upon the posterior root of the fifth cranial nerve. All of these are in pairs except the ganglion of Ribes, making altogether eleven ganglia.

In addition to these, we find in the internal ear the "ganglion of Corti" (a celebrated Italian anatomist), situated on the cochlear nerve (branch of the auditory); upon the glosso-pharyngeal nerve in the jugular foramen, the "jugular" and "petrous" ganglion; in the same foramen, another "jugular ganglion" upon the root of the pneumogastric nerve; and upon the trunk of the pneumogastric after it emerges from the jugular foramen, the "inferior ganglion," which will increase the number of cephalic ganglia to twenty-one, besides the twelve great ganglionic bodies of the encephalon, usually enumerated in connection with the cerebro-spinal system.

Below the base of the skull, the ganglia usually included in the sympathetic system form two gangliated cords, or a double axis, extending along on each side of the vertebral, or spinal column, parallel with one another as far as the sacrum, where they converge; and, in front of the coccyx, communicate through a small, single ganglion, called the "coccygeal," or "ganglion impar" (odd ganglion).

On account of the relation of these two series of ganglia to the vertebral column, the great sympathetic system has been called the "vertebral nerve." Gall terms it the "nervous system of the automatic functions." It was also called the "trisplanchnic nerve," because it gives origin to the three splanchnic (visceral, or intestinal) nerves.

The two series of ganglia lying along the vertebral column from the base of the cranium to the coccyx, consist of twenty-four pairs,—three cervical, twelve dorsal, four lumbar, and five sacral,—all connected by communicating branches with each other and with the coccygeal ganglion (ganglion impar); and according to some authors with the ganglion of Ribes (a single and mesial ganglion) in the brain. Now, upon the posterior roots of the spinal nerves we find thirty pairs of ganglia, which are more or less intimately connected with the sympathetic system; and if we include these and the ganglia found in connection with the cranial nerves, we shall have, altogether, one hundred and thirty of these ganglia, besides the twelve great ganglia generally enumerated as parts of the brain which is the center of the cerebro-spinal system. Small ganglia are also found in the substance of the

heart, and two large gangliform masses (the semilunar ganglia) in connection with the solar plexus, making in all one hundred and forty-four sympathetic centers. The semilunar ganglia, two in number, are situated by the side of the cœliac axis, close to the supra-renal glands.

The **ophthalmic**, or **ciliary ganglion**, is situated in the back part of the orbit, and is about the size of a pin's head. Its branches are distributed to the ciliary muscle and iris.

The **spheno-palatine**, or **Meckel's ganglion**, is the largest of the four cephalic ganglia included in the sympathetic system. It is deeply placed in the spheno-maxillary fossa (space between the upper jaw and sphenoid bone), behind the palatine (relating to the roof of the mouth) branches of the superior maxillary nerve. It gives off numerous branches to the orbit, palate, nose, and throat. Among its branches are the palatine, naso-palatine, Vidian, and pharyngeal.

The **Vidian nerve** passes backward through the Vidian canal in the sphenoid bone, and divides into the large petrosal and carotid branches. The **large petrosal** enters the hiatus Fallopii in the petrous portion of the temporal bone, and joins the facial nerve in the Fallopian aqueduct (aquæductus Fallopii). The carotid branch of the Vidian enters the carotid canal to join the carotid plexus.

The **otic** ("ear," — it sends a branch to the middle ear, or tympanum) **ganglion**, or ganglion of Arnold, is a small ganglion, although twice the size of the ophthalmic. It is situated near the Gasserian ganglion at the inner side of the inferior maxillary nerve. It sends a filament to the tensor tympani, and another to the tensor palati muscles.

The **submaxillary ganglion** is situated above the deep portion of the submaxillary gland, within the angle of the lower jaw. It sends filaments to the submaxillary gland, and its duct (Wharton's), and to the gustatory and facial nerves.

The three cervical (neck) ganglia of the sympathetic system, or pairs of ganglia, are designated as superior, middle, and inferior. They are situated respectively nearly opposite the third, fifth, and seventh cervical vertebræ. The middle cervical is sometimes wanting.

The cardiac (heart) **nerves**, three in number on each side (superior, middle, and inferior cardiac), are derived from the cervical ganglia, and help to form the great **cardiac plexus**, which is situated in front of the bifurcation of the trachea, and behind the arch of the aorta.

The **dorsal**, or **thoracic ganglia** of the sympathetic system rest against the heads of the ribs, and are covered by the parietal layer of the pleura (pleura costalis). The **splanchnic** (visceral) **nerves**, three in number on each side, are derived from the dorsal ganglia. The

Fig. 235.

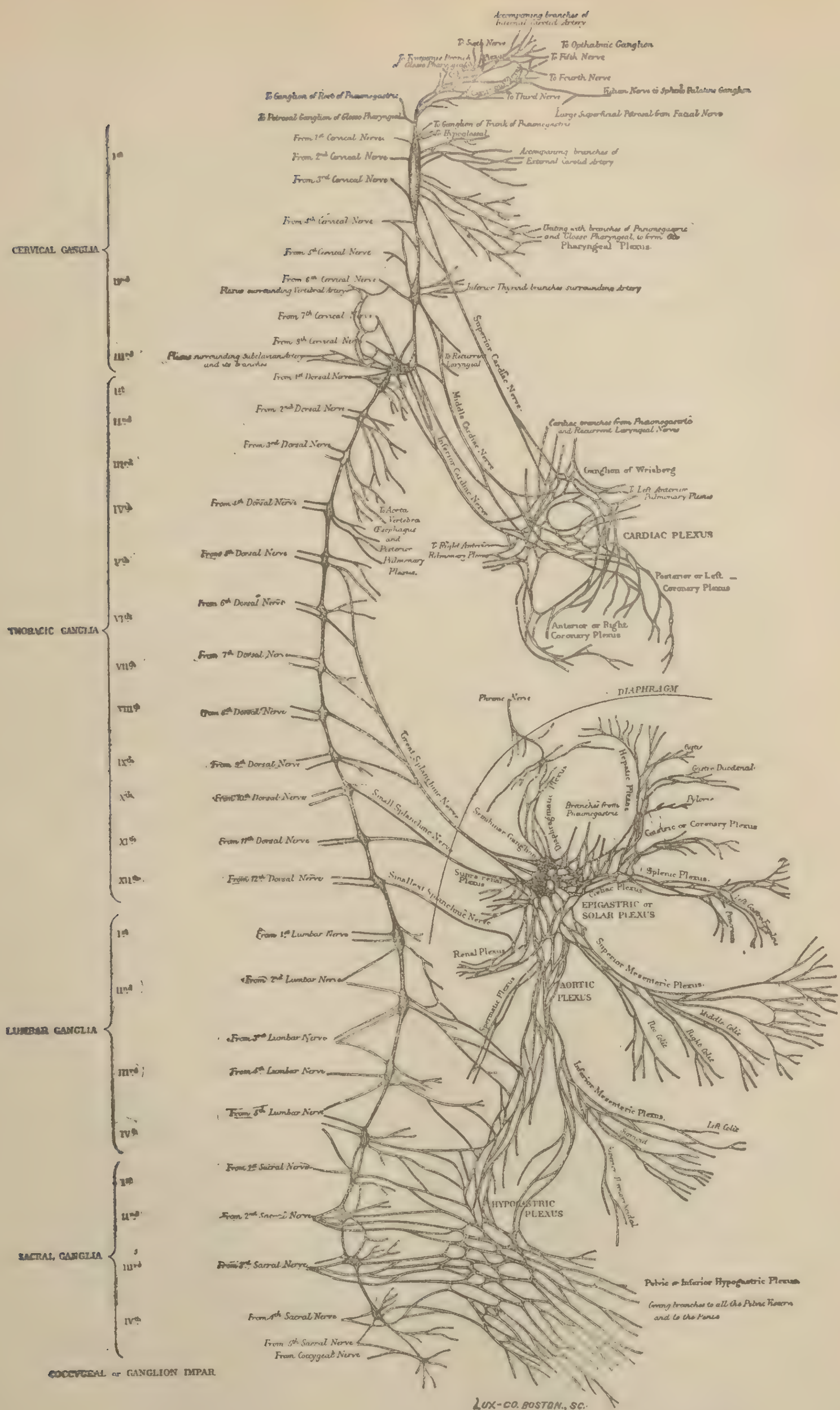


DIAGRAM OF GANGLIA, PLEXUSES, AND NERVES OF THE SYMPATHETIC SYSTEM.

great splanchnic nerve is formed chiefly by branches from the sixth, seventh, eighth, and ninth dorsal ganglia; the **lesser splanchnic** from the tenth and eleventh; and the **smallest** (or renal) **splanchnic** from the twelfth dorsal ganglion on each side. The great splanchnic forms a large round cord of considerable size, which descends in the posterior mediastinum, perforates the crus (leg) of the diaphragm, and terminates in the **semilunar ganglion.** The lesser splanchnic passes through the diaphragm with the great splanchnic, and joins the cœliac plexus. The smallest splanchnic joins both the cœliac and renal plexus.

The lumbar and sacral ganglia of the sympathetic system form numerous plexuses in the lumbar and sacral (or pelvic) regions.

The more important *plexuses* of the sympathetic system are the **carotid**, situated on the outer side of the internal carotid artery; the **great** (or deep) **cardiac**, already described in connection with the cardiac nerves from the cervical ganglia; the **superficial cardiac**, beneath the arch of the aorta; the **solar plexus** (called also the "epigastric"), situated between the stomach and the crura of the diaphragm; and the **hypogastric plexus**, situated in front of the promontory of the sacrum.

The solar plexus supplies all the viscera of the abdominal cavity, and is intimately connected with the two semilunar ganglia (plural of ganglion). Numerous pairs of plexuses are derived from the solar plexus. The following may be named: the **phrenic, cœliac** (the cœliac subdivides into **gastric, hepatic,** and **splenic**), **supra-renal, renal, spermatic, superior,** and **inferior mesenteric.**

Numerous ganglia, not previously mentioned, are developed upon the sympathetic nerves of the solar plexus in connection with the viscera.

ORGANS OF SENSE.

A SENSE is a faculty, possessed by animals, of perceiving impressions from natural objects.

The senses are five in number: sight, hearing, smell, taste and touch.

The **organ of sense** is the instrument by which the mind is brought into relation with the objects of sense. The skin is the principal seat of the sense of touch; the tongue, of taste; the nose, of smell; the eye, of sight; and the ear, of hearing.

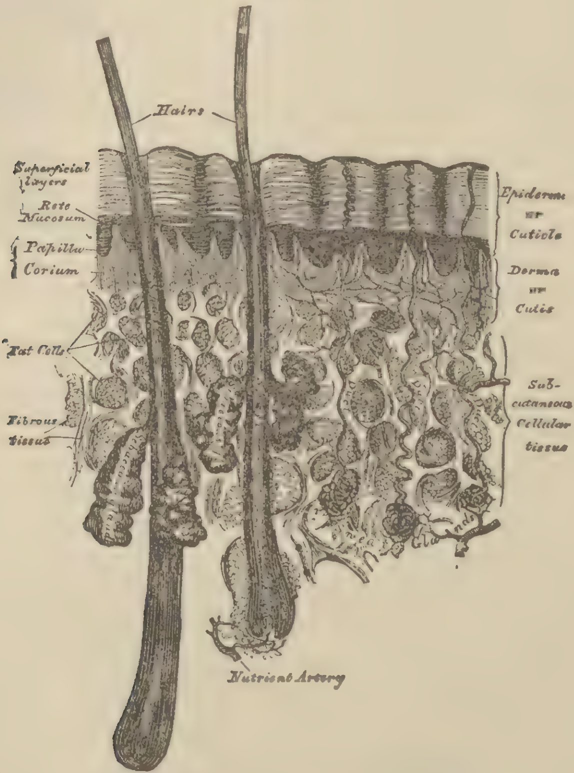
The **skin** is the common integument (covering) of the body, the principal seat of the sense of touch, and an important excretory, or eliminating organ. It consists of two layers. The outer layer is called the cuticle (little skin), epidermis (upon the skin), or scarf-skin. The inner layer is called the "true skin" (cutis vera), or derma (Greek term for "skin"). The term "corium" is used by some authors as synonymous with derma, or cutis vera (true skin), and other authors use the same term to signify the deep layer, or base of the skin; while the superficial layer is called the papillary layer, because it contains the **papillæ**, which are the special organs of touch.

The **epidermis, cuticle**, or **scarf-skin**, is epithelial (formed of flattened cells, or scales), and contains, at its base, the pigment (coloring) cells of the dark races. When the cuticle of the colored man is worn away, as it often is in the palm of the hand, the skin appears white. The under part of the cuticle, which contains the pigment cells, has been called the **rete mucosum** (mucous net) The outer part of the cuticle is, in some situations, hard and horny, depending much upon the amount of external pressure and friction. It is the outer flattened and hardened cells, retained in place by external pressure until numerous layers of hardened cells form beneath them, that constitute a "corn;" and when these hardened cells, which, as a whole, take the form of an inverted cone that presses into the flesh, are removed, the corn is cured temporarily. The cuticle, or scarf-skin, is deciduous (falling off), like the outer bark of a tree, corresponding to the "epithelium" (membrane

composed of flattened cells) of mucous membranes. The **cuticle** is formed by the exudation (oozing of material through the pores) of cells, and contains neither blood-vessels nor nerves.

The **derma**, or **cutis vera** (true skin), is tough, flexible, highly elastic, and when tanned, forms leather. Its frame-work is composed of interlacing bundles of white fibers, intermixed with a small proportion of yellow, elastic fibers. The interlacing of the bundles of fibers of the various tissues of the body forms intervening spaces, called areolæ

Fig. 236.



INTEGUMENT, OR SKIN — MAGNIFIED.

(diminutive of areas, and signifying little spaces); hence, tissue formed of interlacing fibers is termed fibro-areolar (composed of fibers and areolæ) tissue. The true skin contains numerous blood-vessels, lymphatics, and nerves.

The fibro-areolar tissue of the skin is more abundant in the *deeper* layers; is more dense and firm, and has larger meshes (or areolæ). Toward the surface, the fibers and meshes become finer; and the

superficial layer, which lies next to the rete mucosum (mucous net) of the cuticle, is covered with numerous small, conical, vascular (full of vessels, generally applied to blood-vessels) eminences, called papillæ (nipple-like eminences, which contain the ultimate expansions of blood-vessels and nerves).

The papillæ of the mucous membranes of the body are generally called "**villi**" ("tufts of hair," because they are covered with fine down). The average length of one of the papillæ of the skin is about .004 centimeters ($\frac{1}{100}$ of an inch), and its diameter at the base, .0016 centimeters ($\frac{1}{250}$ of an inch). They are most numerous in parts endowed with great sensibility, as at the ends of the fingers and toes, where they are arranged in rows and curved lines, forming elevated ridges, which may be seen on, or through the cuticle, which covers them. The rows, or lines of papillæ are sub-divided by transverse furrows, and thus regularly disposed into square-shaped masses, in the center of each of which is the microscopic opening of the duct of a sweat-gland, which forms one of the **pores of the skin.** The sweat-duct has a spiral form as it passes through the layers of the cuticle. The sweat-glands, together with hair follicles, sebaceous glands, and adipose (fatty) tissue, occupy the meshes, or areolæ of the fibro-areolar tissue, which constitutes the framework of the skin.

The nails, hairs, sebaceous and sweat glands are considered as appendages of the skin. The nails and hairs are **modifications of the cuticle,** and when scalded, come off with it.

The **nails** are placed upon the dorsal (back) surface of the ends of the fingers and toes. Each nail has a root, body, and free edge. The root is implanted into a groove of the skin; the exposed part covering the back of the digital (finger, or toe) extremity is the body; and the anterior extremity, free on both surfaces, is the free edge. That part of the body of the nail near the root, which is of whiter color, owing to less vascularity of the papillæ beneath, is called, from its appearance, "lunula" (little moon). The plural of this word is lunulæ. The matrix (from mater, "mother") is that part of the cutis vera beneath the body and root of the nail on which the nail grows. It is by the growth of new cells at the root and under surface of the body that the nail advances forward, and maintains its thickness. The chemical composition of the nails resembles that of the epidermis; but the nails contain, proportionally, more carbon and sulphur.

Hairs (Latin pili) are found on nearly every part of the surface of the body, excepting the palms of the hands and soles of the feet. They vary much in length, thickness, and color, in different persons and races. On some parts they are so short as not to project beyond the surface of

the part containing them ; while upon the scalp, in some instances (the Sutherland sisters), the hair has grown to the great length of more than two meters (seven feet). The hair in different parts of the body receives different names : that upon the head is termed a capillus (capitis pilus, —hair of the head) ; the eyelashes are the cilia (plural of cilium, "winker") ; and that upon the face is termed, collectively, the beard.

Each hair (pilus, or capillus) consists of a root, shaft, and point. The root is bulbous at its extremity, softer in texture than the shaft, and is lodged in a sheath of epidermis, formed by an inversion of the integument, and called the **hair-follicle** (little bag). When the hair is long, the follicle extends into the tissue beneath the skin. At the bottom of each hair-follicle is a conical (cone-like), vascular (full of blood-vessels) eminence, or papilla, upon which the root of the hair rests, and which supplies material for the growth of the hair. The papilla at the root of the hair is called "papilla pili" (papilla of the hair, or hair-papilla), although it is similar to those found upon the surface of the skin. The hair-follicles are usually implanted obliquely in the skin, so that the hairs lie down more or less flatly upon the surface of the scalp ; but muscular fibers are so connected with these follicles that they can, by contraction, erect the hair, and cause it to "stand on end."

Opening into each follicle are one or more sebaceous (tallowy) glands. These glands are found in most parts of the skin, and often impart to individuals a peculiar odor, which can be perceived and distinguished by sensitive persons. Their ducts (canals) most frequently open into the hair-follicles, but occasionally upon the general surface. The **Meibomian glands**, (named from Meibomius, although known long before his description of them) situated in special grooves in the tarsal cartilages of the eyelids, are sebaceous glands.

The shaft, or stem of the hair, is usually described in three parts,—the medulla (middle part, or pith), the fibrous, and the cortex (rind), or cuticle of the hair. The medulla is sometimes wanting, and generally so toward the point of the hair. The medulla consists of rounded cells, more or less colored, and, usually, contains more or less air-cavities. When the air-cavities are very numerous in the medulla, caused by shrinking of the cells, the hair appears white (turns gray), on account of the light reflected from the walls of these numerous cavities, like those in the foam of water.

The fibrous portion forms the chief part of the shaft. This portion is made up of fusiform (spindle-shaped) fibers, or greatly elongated cells, and contains pigment (coloring) granules, upon which depends chiefly the color of the hair.

The cuticle (or cortex) of the shaft is composed of flattened cells, or scales, which overlap each other like the scales of a fish, and have their free edges directed toward the point of the hair. In the hair-follicle. these scales interlock with the scales of the investing integument, and hold the hair quite firmly from falling.

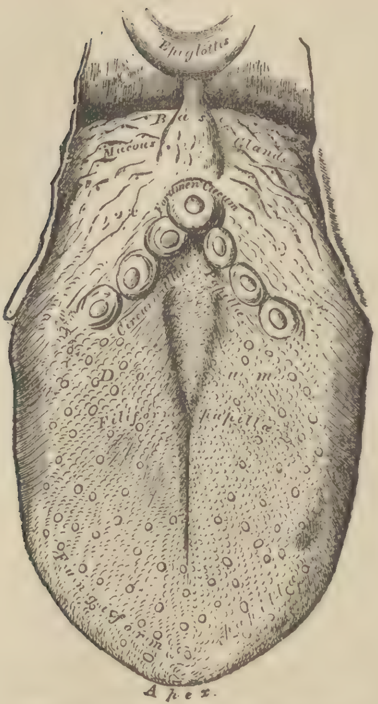
When a hair is lost, if the papilla at the root is not too severely injured, a new hair will be formed, but not otherwise. The growth of the hair depends upon the vigor of the circulation in the papillæ. The same may be said of the nail in regard to the papillæ of the matrix, The hair serves for ornament, for protection, and also as a conductor of electricity, which accumulates in the system. In the language of a friend of the author "It serves to connect the visible with the invisible."

The **sudoriferous** (sweat-bearing) **glands** secrete the perspirable matter (sweat), and carry off from the blood a large proportion of its waste. They are found in almost all parts of the skin, and are so numerous that their number is estimated at two million. They are most numerous on the palm of the hand, where their number, according to Krause (pronounced Kröû'zā), is 2,800 on a square inch of integument, or 500 on each cubic centimeter. On the back of the body, where they are least numerous, they number 70 on each cubic centimeter, or 400 to the square inch. They usually lie in the sub-cutaneous (under the skin) tissue; and consist of one or more minute convoluted tubes, with a spiral duct opening upon the surface.

THE TONGUE.

The tongue (lingua, glossa, or glotta) is a muscular and movable organ, situated in the mouth. Its name is synonymous with language, or speech, on account of its usefulness in articulation (the formation of joints, or syllables, in words). It is described by anatomists as the organ of taste, but has other important functions in eating, drinking, and speaking. Its upper surface, or dorsum (back) is free. Its lower surface is also free at the tip, or anterior third, while the body and base are attached to the lower jaw and hyoid bone. The base is also called the root of the tongue (radix linguæ). The tongue is composed almost entirely of muscles, and is covered by mucous membrane, which has three varieties of papillæ. It is these papillæ that give to the tongue its characteristic roughness. They are distinguished by their size, and also by their shape. The great papillæ are the "circumvallate" (environed); the middle in size are called "fungiform" (mushroom-shape); and the small are "filiform" (thread-shape).

Fig. 237.

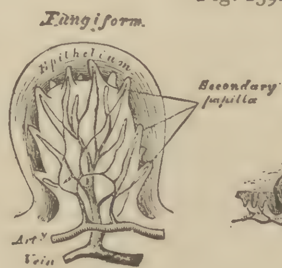


UPPER SURFACE OF THE TONGUE.

The circumvallate papillæ are only eight or ten in number, are situated far back upon the dorsum ("back," or upper surface), and are arranged in the shape of a semi-circle, or letter "V"; the fungiform are scattered irregularly and sparsely over the dorsum of the tongue;

Fig. 238.

Fig. 239.



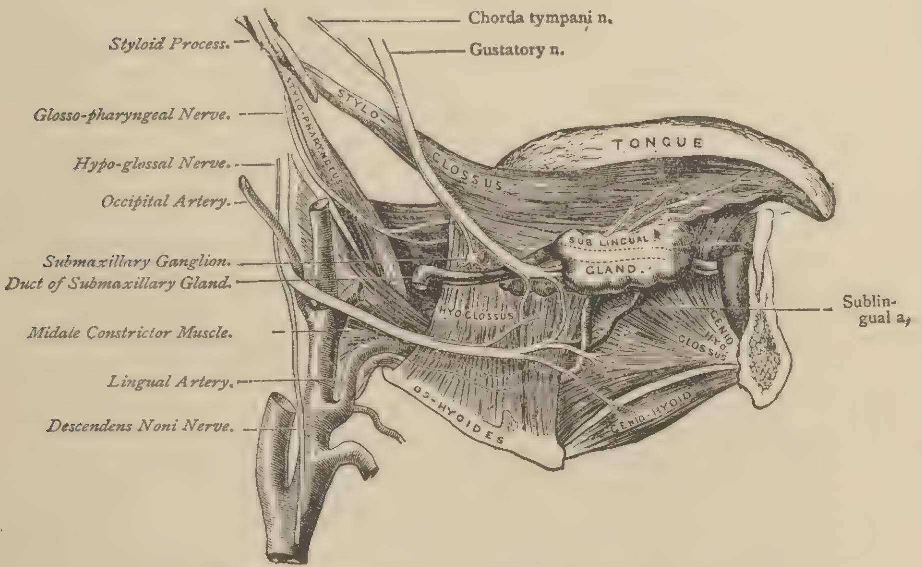
THE THREE VARIETIES OF PAPILLÆ—MAGNIFIED.

and the filiform, or small papillæ, cover the anterior two thirds of the dorsum.

At the point where the two lines of circumvallate papillæ meet, there is a fissure, or depression, called the foramen cæcum (blind opening),—so-called because it terminates in a sac. A foramen of similar name is found in the frontal bone, and another in the medulla oblongata.

The tongue is attached by folds of mucous membrane to the epiglottis, and by the pillars of the fauces to the soft palate. A fold of mucous membrane beneath the tip of the tongue is called the **frænum linguæ** (bridle of the tongue).

Fig. 240.



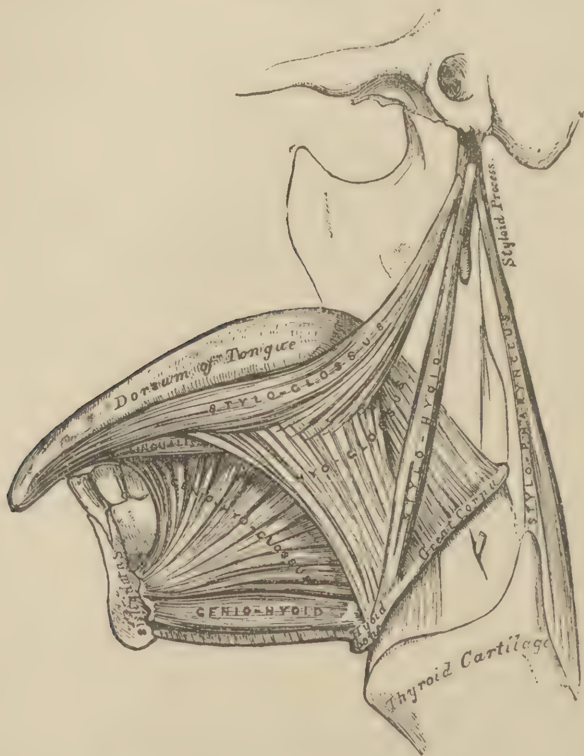
MUSCLES, VESSELS, AND NERVES OF THE TONGUE.

The substance of the tongue is made up of five pairs of muscles. These are the genio-hyo-glossus, hyo-glossus, lingualis, stylo-glossus, and palato-glossus, whose names indicate their attachments.

The **genio-hyo-glossus** (chin, hyoid bone, and tongue) is a thin, flat, triangular muscle, placed vertically on either side of the median line, and beneath the body of the tongue. It is attached to the inner surface of the lower jaw at the symphysis (junction of the right and left sides ; the word symphysis signifies "growing together"), and from this point its fibers diverge like a triangular fan, to be inserted into the whole length of the under surface of the tongue. Some of the lower fibers are inserted into the body of the hyoid bone, and when contracted draw it

forward toward the chin, and a few are continued into the side of the pharynx (throat). At the back part of the tongue, the two muscles are separated by the fibrous septum, which extends through the middle of this organ. The lower and posterior fibers of these muscles protrude the tongue from the mouth, and their upper and anterior fibers retract it. Acting as a whole, they draw down the middle of the tongue, and render it concave from side to side. These muscles (the right and left) are supplied by the hypo-glossal (ninth cranial) nerves.

Fig. 241.



MUSCLES OF THE TONGUE—LEFT SIDE.

The **hyo-glossus** is also a thin, flat muscle, and extends from the side of the body and base of the tongue to the hyoid bone below. Its name indicates its attachments. It is described by some anatomists in three parts (basio-glossus, kerato-glossus, and chondro-glossus), owing to the different direction of its fibers, which are attached respectively to the body, greater horn (cornu), and lesser horn, of the hyoid bone. The hyo-glossus muscles draw down the sides of the tongue, and thus

render it convex from side to side. They are supplied by the hypo-glossal nerves.

The greater part of the substance of the tongue is formed by the **lingualis** (tongue) **muscle.** Its fibers run in three directions: those upon the upper and lower surfaces are longitudinal, and extend from its base to the apex; between these are transverse fibers, which arise from the median septum (partition), and a large number of vertical fibers. The longitudinal fibers of the lower surface draw down the apex, and render the tongue convex from before backward; the superior longitudinal fibers draw up the apex, and render the tongue concave from before backward; the transverse fibers narrow and elongate the tongue; and the vertical fibers flatten and broaden it,—supplied by the ninth cranial nerves (hypo-glossal).

The **palato-glossus** (palate and tongue) is called, also, the constrictor isthmi faucium (constrictor of the isthmus of the fauces). It forms the anterior pillar of the soft palate, and extends from the soft palate on each side of the uvula to the side and back of the tongue in front of the tonsil, and draws the base of the tongue upward, or the soft palate downward. The palato-glossus is supplied from Meckel's ganglion.

The **stylo-glossus** (styloid process and tongue) extends from the styloid process of the temporal bone downward and forward to the side of the tongue. It can draw the base of the tongue upward and backward, or, acting one side at a time, can turn the apex of the tongue to either side. The hypo-glossal nerves supply all the *voluntary* muscles of the tongue.

THE NOSE.

The nose is the organ of smell, or, more properly, the seat of the sense of smell. It consists of the external nose and internal nasal fossæ. The nose, considered externally, occupies the middle part of the face, and forms a covering for the two anterior apertures (nostrils) of the nasal fossæ. It is formed of bone above and cartilage below, and is covered by the common integument of the body, and lined with mucous membrane, which here takes the name of pituitary (mucus, or phlegm), or Schneiderian membrane. This membrane is continuous with that which lines the numerous cavities communicating with the nasal fossæ, pharynx (throat), and tympanum (drum, or middle ear).

The two nasal fossæ are separated by a median wall, called the septum. The septum, like the anterior walls of the nose, is partly bone and partly cartilage. The two nasal fossæ communicate with the ex-

Fig. 242.

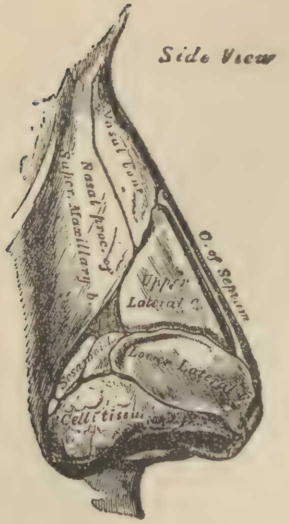
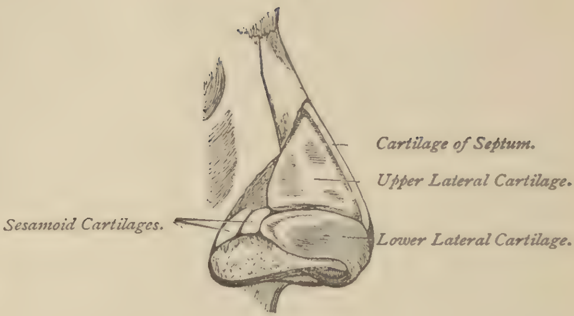
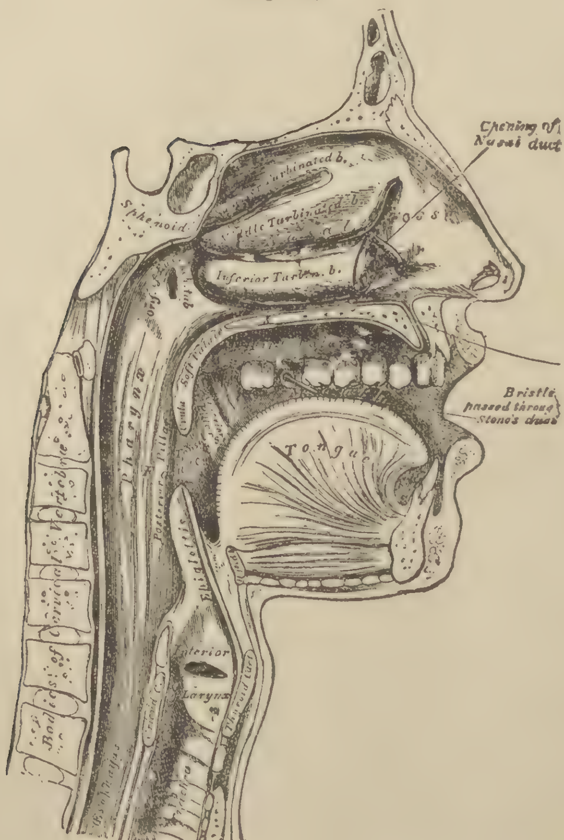


Fig. 243.



BONES AND CARTILAGES OF THE NOSE.

Fig. 244.



PHARYNX, LARYNX, MOUTH, AND NASAL FOSSÆ.

ternal air in front by means of two openings, called the anterior nares, or nostrils (nose-holes); and with the pharynx (throat) by means of the two posterior nares. If we speak of a single nostril, whether right or left, anterior or posterior, it is properly called naris (singular of nares). The external movable sides of the anterior nostrils are called the "alæ" (wings) of the nose. A single wing is the "ala" (pronounced alar) of the nose.

Each nasal fossa (cavity) is divided by the three turbinated bones into **three meatuses** (passages), called, respectively, the superior, middle, and inferior meatus (passage).

The superior and middle turbinated bones are, in the adult, parts of the ethomid, but the inferior turbinated usually remain as separate bones. Each turbinated bone, on either side, is situated on the outer wall of the nasal fossa, above its corresponding meatus.

The pituitary membrane is provided with a layer of mucous glands, which are most numerous at the middle and back part of the nasal fossæ.

The arteries of the nasal fossæ are derived chiefly from the ophthalmic and internal maxillary; but the external nose is largely supplied by the facial.

The olfactory nerves have been traced over the upper third of the septum, and over the surface of the middle and superior turbinated (also called spongy) bones.

THE EYES.

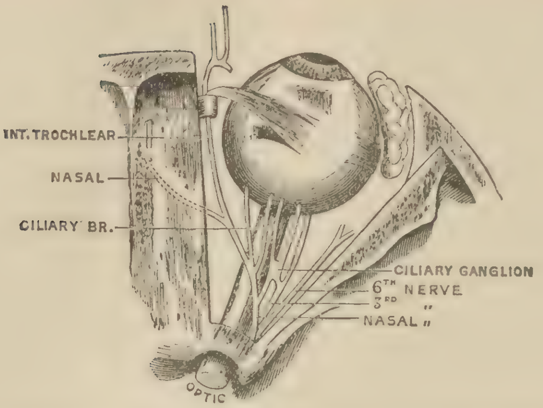
The eye is the organ of sight, or vision. It is contained in a cavity of the cranium (skull) called the orbit. The eye (Latin, "oculus") has been called the window of the soul. In anatomy, the term "eyeball" is used in describing the organ of vision, as being more definite than the word eye.

The **orbits** are two large pyramidal cavities formed by the aid of seven different bones, which afford protection to the eyeballs. It is the sight of these cavities, deprived of their peculiarly expressive organs, which gives to the skull its ghastly appearance, and yet in life they serve an excellent purpose. The eyeball is further protected by the eyelids, eyelashes, and eyebrows.

The axes of the eyeballs are nearly parallel, while the axes of the orbits converge backward, so that their apices (plural of apex) are separated from each other only by the body of the sphenoid bone.

The eyeball is almost a perfect sphere, and is called by some ancient and modern writers an "orb," but it has the segment of a smaller sphere engrafted upon its anterior part.

Fig. 245.



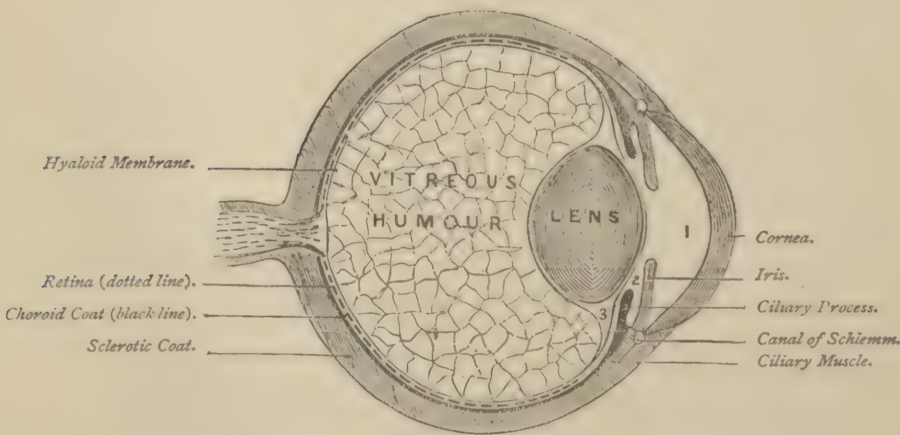
THE EYEBALL, WITH THE OPTIC AND OTHER NERVES.

The optic nerve enters the eyeball at its back part, and a little to the inner side.

The eyeball is covered by three coats, and contains within it three refractive media. The coats in their order from without inward are the sclerotic (hard), the choroid ("skin-like," having many vessels like the skin), and the retina (from "rete," a net). The refractive media (two of them are called "humors" and one a "lens") are the aqueous (watery) humor, the crystalline ("clear," like ice) lens, and the vitreous (glassy) humor. The latter is also called the vitreous body.

The **sclerotic** (hard) **coat** is the outer, firm, white covering of the

Fig. 246.



VERTICAL SECTION OF THE GLOBE OF THE EYE.

1. Anterior Chamber, filled with aqueous humor. 2. Posterior Chamber of the aqueous humor. 3. Canal of Petit.

eyeball. It gives shape and protection to the refractive media within, and also affords attachment for the six muscles that move the eyeball. The sclerotic coat, which is opaque, does not cover the segment of the smaller sphere in front, but its place is supplied by a transparent membrane called the "cornea" (horny substance). The **cornea** fits into the sclerotic coat like a crystal into the case of a watch. The sclerotic coat is that part which in common language is sometimes called the "white of the eye."

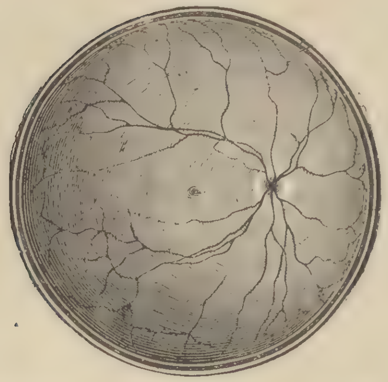
The **choroid coat** is the second covering of the eyeball. It lines the sclerotic internally, and its inner surface is covered like a camera obscura (dark chamber) with dark pigment, which absorbs the rays of light that fall upon the retina, and thus prevents reflection. Like the

Fig. 247.

COATS OF THE EYEBALL, YELLOW SPOT, AND CENTRAL ARTERY OF THE RETINA.

sclerotic, the choroid coat does not completely cover the anterior portion of the eyeball, but leaves an opening, or window, for the admission of light. The opening is called the "**pupil**" (little girl, or doll, from the image seen in the eye). The pupil is dilated (opened wider) and contracted (made smaller) by means of two sets of muscular fibers — a circular and a radiating set — contained in the *iris* (membrane around the pupil). The **iris** is continuous with the choroid coat, and is that part of the choroid which lies back of the cornea, and is differently colored in different persons. It is a perforated curtain, which graduates the amount of light admitted through its central opening. Its posterior surface is covered with a thick, black substance, and is called the **uvea** (from uva, "grape"), on account of the resemblance of its coloring-matter to the pulp of a black grape. Iris was the name of the rainbow.

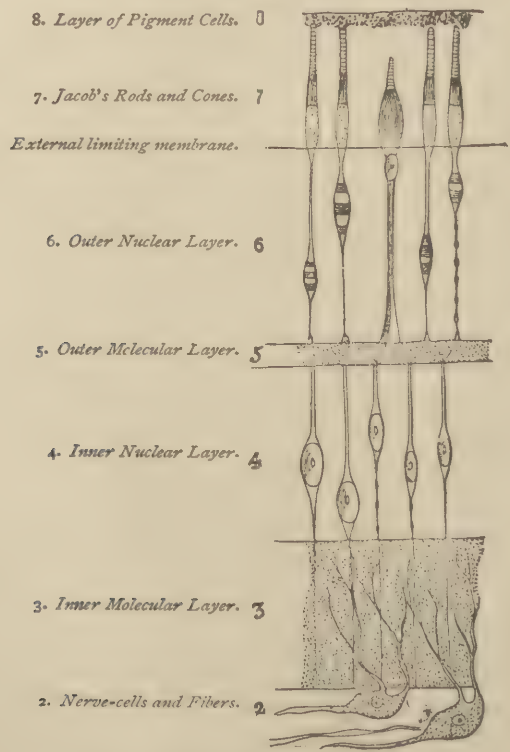
Fig. 248.



THE RETINA, AS SEEN FROM THE FRONT.

The **retina** (from rete, "net") is the third coat of the eyeball. It lies upon the inner surface of the choroid coat, and surrounds the vitreous body. The latter, the vitreous body, or humor, fills the

Fig. 249.



LAYERS OF THE RETINA — MAGNIFIED.

The lower part of the figure represents the innermost layers.

greater portion of the eyeball, and is transparent, so as to admit the rays of light to the retina. The retina lines the posterior four fifths of the eyeball, extending in front to the base or outer margin of the iris. The hyaloid (glass-like) membrane separates the retina from the vitreous body. The retina is a semitransparent coat upon which the images are received. At its center, posteriorly, is the yellow spot (macula lutea), with a depression in its center called "fovea centralis" (central pit). A little to the nasal, or inner side of the yellow spot is the entrance of the optic nerve and central artery of the retina. The retina itself is divided into six or more layers. The external layer, unless we reckon a pigmentary layer which we have considered with the choroid, is the layer of rods and cones (usually called Jacob's rods and cones) lying perpendicular to the surface; then come successive layers, as given in Fig. 249; and last of all and next to the hyaloid is the internal limiting membrane (membrana limitans), which does not appear in the cut. The retina is the membrane to which is distributed the optic nerve.

The **vitreous** (glassy) **body**, which comprises the greater portion of the eyeball, is a transparent mass of a gelatinous consistence that fills the eyeball behind the crystalline lens, extending from the retina behind to the crystalline lens in front. In early life the vitreous body is contained in large cells formed by the hyaloid coat which surrounds the vitreous body. The cavity filled by the vitreous body is called by some authors the posterior chamber of the eye, while other authors apply the same term to the space between the iris and the crystalline lens. To avoid confusion, we may designate the latter as the *posterior chamber of the aqueous humor.*

Fig. 250.

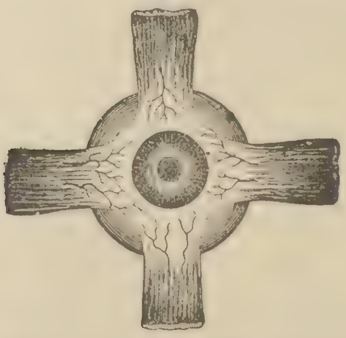
THE CRYSTALLINE LENS, SHOWING ITS CONCENTRIC, OR ELLIPTICAL LAYERS.

The **crystalline lens** is a transparent body, situated between the vitreous and aqueous (watery) humors of the eye, its anterior surface lying just behind the iris, but separated from it by a small quantity of the aqueous humor which passes freely through the pupil, and fills the

chambers on both sides (or surfaces) of the iris, which hangs like a curtain suspended in the watery (aqueous) humor. The crystalline lens is a double convex lens, with its anterior surface somewhat less convex than its posterior surface. The lens is composed of an albuminoid substance inclosed in a capsule, called "capsula lentis" (capsule of the lens), and has a number of elliptical layers inclosed one within another, like a nest of boxes, or bowls.

The **aqueous humor** fills the space, or spaces between the cornea in front and the crystalline lens which lies behind the iris. This space for the aqueous humor is divided in part by the iris into an anterior and posterior compartment, called *chambers of the aqueous humor*. These two chambers are separated in part only by the iris, and communicate through the **central opening of the iris**, called the pupil.

Fig. 251.



INSERTION OF THE RECTI MUSCLES.

The **ciliary muscle** is a ring of involuntary, muscular tissue situated at the anterior part of the choroid coat, around the margin of the iris, and serving to adjust the eye to different distances by compressing the vitreous body and advancing the crystalline lens. In old age the lens usually becomes flattened on both surfaces. The suspensory ligament of the lens is a thin, transparent membrane that assists to retain the lens in position.

The arteries of the globe of the eye are the ciliary and the arteria centralis retinæ (central artery of the retina). The latter supplies the retina, and in the fœtus, prior to the seventh month, sends a small branch forward through the vitreous body, to supply the crystalline lens.

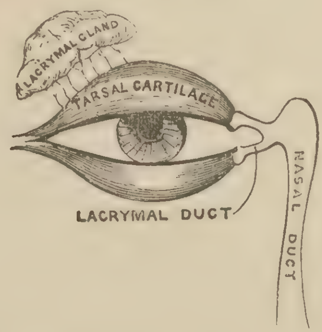
The **nerves of the eyeball** are the optic, the long ciliary (a branch of the nasal), and the short ciliary from the ciliary ganglion.

When the optic nerve, or retina, is oppressed with too much light, the ciliary nerves, acting upon the circular fibers of the iris, contract the

pupil and exclude a part, and *vice versa;* when there is too little light, the radiating fibers of the iris cause the pupil to dilate.

The conjunctiva, eyelids, lachrymal apparatus, and eyebrows are generally described as appendages of the eye. The **conjunctiva** is a mucous membrane that lines the lids, and is reflected from the lids upon the globe of the eye, which it covers in front. Over the cornea it is little more than an epithelial layer.

Fig. 252.

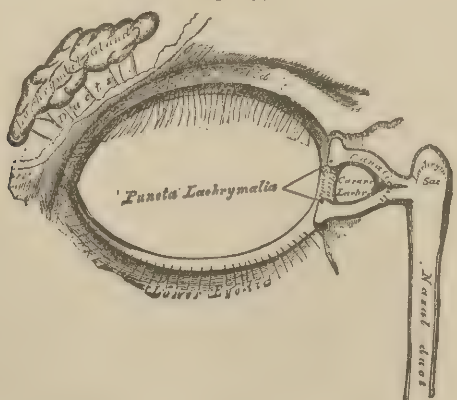


THE LACHRYMAL APPARATUS, AND TARSAL CARTILAGE.

The **eyelids** (palpebræ) are movable folds, for the better protection of the eye, and also serve to keep the front of the eye, which is much exposed to the action of the atmosphere, in a properly moistened condition.

The lids are two in number,—an upper and a lower lid. The upper lid (palpebra superior) is more movable, and is lifted by a special muscle, the levator palpebræ superioris (lifter of the upper lid).

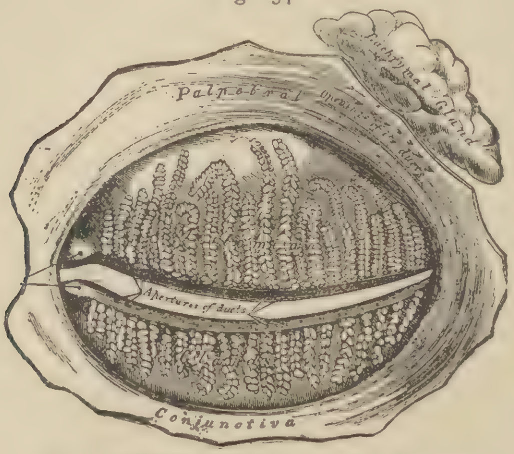
Fig. 253.



THE LACHRYMAL GLAND, DUCTS, AND CANALS.

The angle where the upper and lower lids meet is called the **canthus** (Greek word for angle, or corner). The two angles are distinguished as the internal and external canthus. At the internal canthus, near the nose, the lids are separated by a small space called the lachrymal lake (lacus lachrymalis). At the margin of the lake, on the edge of each lid, is a minute opening, called the punctum lachrymale (lachrymal point), which is the beginning of the **lachrymal** (tear) **canal.** The latter conveys the tears through the nasal duct into the inferior meatus of the nose. The puncta lachrymalia (plural of punctum lachrymale, "tear point") terminate in the lachrymal sac, which is the upper dilated extremity of the nasal duct.

Fig. 254.



THE LACHRYMAL AND MEIBOMIAN GLANDS.

The tears are secreted by the **lachrymal gland,** which lies above the globe of the eye near the outer angle of the orbit. They moisten the inner surface of the lids, and the latter moisten the cornea as they move over its surface in winking. The lid is composed of the tarsal cartilage, covered by the orbicular muscle and skin, and is lined with the conjunctiva.

The **Meibomian glands** lie between the conjunctiva and tarsal cartilage, and secrete a substance to prevent adhesion of the upper and lower lids. They are the largest sebaceous glands in the body.

The *eyelashes* (cilia) are attached to the free edges of the lids, and serve for better protection of the eye. They are a picket-guard for the organ of vision.

THE EAR.

The ear is the organ of hearing. It consists of three parts — the external, middle, and internal ear. The external ear is also known by *three other names;* viz., auricle (little ear), pinna (wing), and pavilion of the ear. The middle ear is known as the **tympanum** (drum), and the internal as the **labyrinth.** The latter is the immediate seat of the sense of hearing.

The tympanum serves only to convey the vibrations of the atmosphere to the labyrinth; and the external ear to direct the same into the external ear-passage (meatus auditorius externus). The external ear consists of cartilage covered with the common integument of the

Fig. 255.

THE EXTERNAL EAR.

body, and attached to the bony margin of the external ear-passage. The deep depression of the auricle behind the meatus is the concha (a concave shell). Below the concha (pronounced kong-ka) is a soft pendulous portion, called the lobule (little lobe).

The elevated rim, or outer circumference of the auricle, or pinna, is the **helix** (tendril of a vine). The smaller rim or ridge, between the helix and concha, is the **anti-helix.**

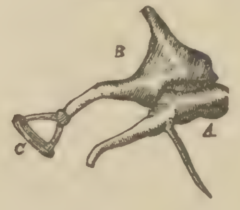
In front of the meatus is a prominence called the tragus (a "goat," on account of its beard in old persons); and opposite the tragus is a prominence in the smaller rim called the **anti-tragus.**

The **external meatus** (meatus auditorius externus) extends from the concha to the membrane of the tympanum (membrana tympani),

which closes the passage completely, so that no insect or liquid can enter the ear farther than the outer surface of the membrane. The external passage is lined with the common integument (skin), which is here provided with glands that secrete the **cerumen** (wax). The wax lubricates the lining of the passage, and is probably offensive to insects.

The **tympanum** (drum), or middle ear, is a cavity formed in the petrous portion of the temporal bone, and is separated from the external ear-passage only by a thin membrane called the "membrana tympani" (membrane of the drum). The tympanum communicates with the pharynx (throat), by means of the **Eustachian tube**, and contains a chain of three small bones, that serve to convey the vibrations of the membrana tympani to the labyrinth. These bones are the malleus (hammer), incus (anvil), and stapes (stirrup). The hammer is attached, by its handle (manubrium), to the membrana tympani, while its head strikes upon the anvil. The anvil connects the hammer with the stirrup (stapes), and the foot of the stirrup closes the oval window (fenestra ovalis), which opens into the labyrinth.

Fig. 256.



OSSICLES (LITTLE BONES) OF THE EAR.

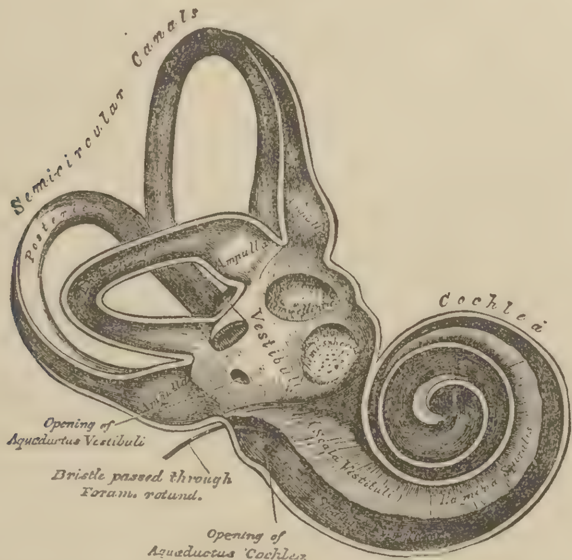
A. The Malleus. B. The Incus. C. The Stapes.

Each of these three bones of the tympanum has two processes: those of the malleus are the short and graceful; those of the incus are the short and long; and those of the stirrup are the two crura (legs), or branches. The latter form the sides of the stirrup. The long process (processus longus) of the incus terminates in a rounded projection where it articulates with the head of the stapes. This rounded part of the incus (anvil), near the stapes, is a separate bone in the fœtus; or, in other words, is an epiphysis of the incus, and is called the "os orbiculare" (rounded bone). It makes the *fourth* ear bone *of the fœtus.* The graceful process (processus gracilis) of the malleus (hammer) gives attachment to the **laxator tympani muscle**, which, passing through the Glasserian fissure, is attached to the spinous process of the sphenoid. The short process (processus brevis) of the malleus gives attachment to the **tensor tympani muscle.** The foot of the stir-

rup is fastened to the circumference of the fenestra ovalis (oval window) by the annular ligament.

The three muscles of the tympanum (drum), are the tensor tympani, laxator tympani, and stapedius. The tensor tympani (tightener of the drum) enters the tympanum by a small canal (canal of Huguier) just above the Eustachian tube. It draws the membrana tympani inward and heightens its tension. The laxator tympani (loosener of the drum) enters the tympanum by the Glasserian fissure. The stapedius arises from the sides of a conical cavity situated within an eminence of bone upon the internal wall of the drum, and called the pyramid. The stapedius depresses the back part of the base of the stapes (stirrup).

Fig. 257.



THE INTERNAL EAR, OR LABYRINTH, LAID OPEN — ENLARGED.

The internal wall of the drum is vertical (perpendicular to the horizon), is partly osseous (bony) and partly membranous, and separates the drum (middle ear) from the labyrinth (internal ear). The membranous part of the internal wall of the drum comprises the two membranes that close the windows (the oval and round, or fenestra ovalis, and fenestra rotunda). The oval window is situated above the round, and communicates with the vestibule of the labyrinth; the round communicates with the cochlea.

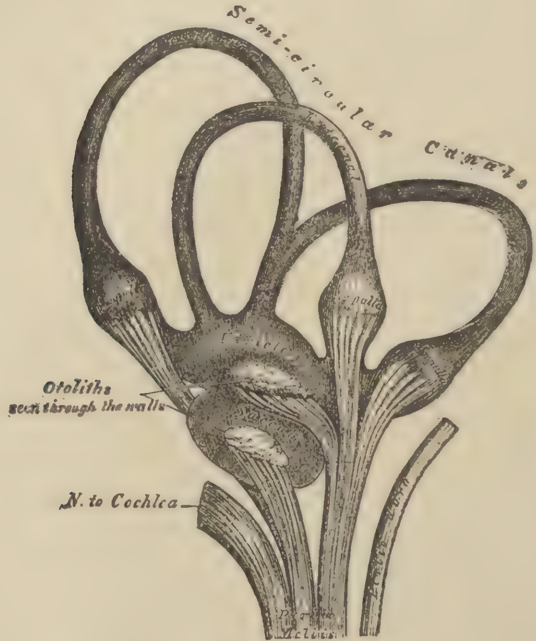
On the posterior wall of the drum are the openings (one large and several small) from the mastoid cells. These cells are numerous, are situated in the mastoid process of the temporal bone, and are lined

with mucous membrane which is continuous with that of the tympanum (drum), or middle ear.

The anterior wall of the tympanum has two openings — one small, for the canal of Huguier, and a larger one for the Eustachian canal. These canals run parallel with each other, and close together downward, forward, and inward toward the throat. The Eustachian tube lies in the Eustachian canal. It is four or five centimeters (about two inches) in length.

The internal ear (the labyrinth) consists of the vestibule, three semicircular canals, and the cochlea (snail shell). The cochlea lies in front of the vestibule, with its base toward the internal ear-passage,

Fig. 258.



COCHLEAR AND VESTIBULAR BRANCHES OF THE AUDITORY NERVE (PORTIO MOLLIS) IN CONNECTION WITH THE FACIAL NERVE (PORTIO DURA) — ENLARGED.

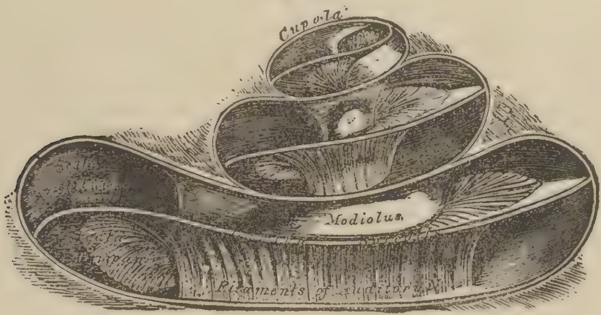
and its apex outward and forward. The vestibule (ante-room, or hall) is the common central cavity of communication between the parts of the labyrinth (winding maze).

The **osseous** (bony) **labyrinth** consists of one central cavity (the vestibule) and four winding passages, which are chiseled out in the petrous portion of the temporal bone. This osseous labyrinth contains the **membranous labyrinth**, and within the latter are the branches

of the auditory nerve. The membranous labyrinth is filled with a fluid called the "endolymph" (clear fluid within), and is surrounded by a fluid called the perilymph (clear fluid around), which separates it from the osseous labyrinth.

The three **semicircular canals** are distinguished as the superior, posterior, and external. They are all at right angles with each other; the superior and posterior canals being vertical, while the external is horizontal. They open into the vestibule. The membranous semicircular canals are much smaller than the bony (osseous) canals in which they float. The bony canals themselves are chiseled out of dense bone, each in the form of a semicircle, and are large enough to admit the wire of an ordinary brass pin. The membranous semicircular canals are a part of the membranous labyrinth, which has the same general form as the osseous (bony) labyrinth in which it lies. The membranous labyrinth is a closed sac, held in position by numerous fibrous bands which stretch between the membranous and bony labyrinths, and convey the blood-vessels and nerve filaments.

Fig. 259.



THE COCHLEA, LAID OPEN — ENLARGED.

The **cochlea** (snail shell) is a spiral tube wound two and a half times round a hollow, conical axis (the "modiolus"). The modiolus is the central axis of the cochlea, and extends from its base to the apex. The modiolus transmits a small nerve and artery (arteria centralis modioli — central artery of the modiolus). The modiolus is further perforated by numerous branching canals, which transmit filaments of the cochlear branch of the auditory nerve. The spiral tube that winds two and a half times round the modiolus of the cochlea is called the "**spiral canal.**" It is about four centimeters (one and a half inches) in length, measured along its outer wall; and about one fourth of a centimeter (one tenth of an inch) in diameter at its commencement, but diminishes in size from the base to the summit. Small as it is, the spiral canal is

divided into three portions, forming three smaller canals, called scalæ (ladders, or stairs). These three scalæ, or canals of the cochlea, are named, respectively, scala tympani (ladder of the drum), scala vestibuli (ladder of the vestibule), and scala media (middle ladder).

The scala tympani is the lower ladder, as it lies beneath the scala vestibuli. It commences at the round window (fenestra rotunda), where it is separated from the tympanum only by a thin membrane.

The scala vestibuli communicates by an oval aperture with the vestibule, and at the apex of the cochlea with the scala tympani, by what is called the helico-trema (spiral foramen). This foramen exists in consequence of the deficiency of the septum (partition), which divides the two scalæ (scala tympani and scala vestibuli) through two of the turns of the spiral canal, but is wanting in the last half turn.

The scala media is a triangular section of the scala vestibuli, cut off from it by a membrane (membrane of Reissner) which extends from the edge of the bony lamina (plate) of the septum to the outer wall of the spiral canal. The septum, between the scala tympani and scala vestibuli, is called the lamina spiralis (spiral plate). It is partly osseous and partly membranous. The osseous part is called the osseous zone, and the other part the membranous zone, or basilar membrane. The osseous zone consists of two thin plates (lamellæ) of bone, between which are numerous canals for the passage of nerve filaments. The scala media (middle ladder or staircase) is bounded by the outer curved wall of the spiral canal, by the membrane of Reissner, and, lastly, by the basilar membrane. Within the scala media, and lying upon the basilar membrane which forms its floor, is the keyboard of the ear — the "organ of Corti." This organ consists of a series of arches and cells which form the termini (extremities) of the filaments of the cochlear branch of the auditory nerve.

The cochlear nerves, or filaments (branches of the auditory) reach the organ of Corti by passing between the two plates of the osseous zone of the spiral lamina (plate).

The auditory nerve divides at the bottom of the internal meatus into two branches — cochlear and vestibular. These branches subdivide into numerous filaments before they enter the membranous labyrinth.

At the ends of the osseous semicircular canals, where they enter the roof of the vestibule, the membranous canals which partially fill them are expanded, and from their shape, take the name of ampulæ (bottles). The membranous semicircular canals communicate with the vestibule by five orifices; the posterior and the superior semicircular canals *uniting*, at one end, before they enter the vestibule.

That portion of the membranous labyrinth which occupies the vestibule consists of two sacs,—the "utricle" (small bag) and the "saccule" (small sac). Upon the wall of these little sacs is found, in each, a little round body composed of grains of carbonate of lime, held by a mesh of delicate fibrous tissue, and called the "otolith" (ear-stone). The otoliths are the weights that are supposed to determine the intensity of sounds.

The semicircular canals probably enable us to determine the direction in which the vibrations reach the ear.

The entrance of air to the tympanum *through the Eustachian tube* affords an equal density of air upon either side of the membrani tympani, and thus prevents its injury.

ORGANS OF DIGESTION.

THE organs of digestion ("bear apart," or distribute) consist of the alimentary (nourishing) canal and its accessory organs. The accessory organs are the tongue, teeth, salivary glands, tonsils, liver, spleen, pancreas, lymphatics, and mesenteric glands. The tongue has been already described as an organ of sense. The **alimentary canal** is a tube of varying length and capacity, extending from the lips upon the face entirely through the chest and diaphragm (divider) into the abdomen ("concealer," because it conceals the viscera), where, after forming many convolutions, it terminates in the colon at the ileo-cæcal valve.

The colon (large intestine) was long regarded as a part of the alimentary canal; but the office which it performs as a drain, or sewer, for the system, as well as its shape and size, shows that it is something entirely different. The ingesta of the alimentary canal is supposed to be suitable for reception into the general circulation, but that of the colon is only suitable for rejection. The alimentary canal is for nourishment; the colon is for waste, or refuse.

The alimentary canal is lined throughout with mucous membrane, and furnished with a coat of muscular fibers governed by the sympathetic nerves. For convenience of reference and description, it is divided into parts, whose names, taken in order, are the mouth, isthmus faucium, pharynx (throat), œsophagus (food-carrier), stomach, duodenum, jejunum, and ileum. The mouth and stomach are dilatations of the alimentary canal.

The duodenum, jejunum, and ileum, together, make up the small intestine. The small intestine extends from the stomach to the colon, and is one continuous tube, having no line of demarkation between the parts into which it is arbitrarily divided. The duodenum is the part next to the stomach, and is about twelve (duodena) fingers' breadth in length. The jejunum (hungry, or empty) extends from the duodenum to the ileum, and the ileum connects with the colon below. The ileum is generally considered longer than the jejunum, but the division is entirely arbitrary. The length and capacity of the alimentary canal depend upon the nature of the food. In the herbivora

(animals that feed on vegetable food) it is much longer than in the carnivora (animals that feed on flesh).

The **mouth** is the superior aperture, or entrance, to the alimentary canal, and is sometimes called the buccal cavity, from the Latin "bucca" (mouth, or cheek). In it we find provision for the mechanical division (mastication) of the food, and for its admixture with an alkaline fluid (the saliva) which is necessary for the process of digestion.

The **mucous membrane** of the mouth is continuous upon the lips with the integument upon the face, and in healthy persons is tinged by the colors of the pink and the rose. It is lined with pavement epithelium.

The mouth is bounded in front by the lips, at the sides by the cheeks, above by the palate (roof of the mouth), and behind by the isthmus faucium (isthmus of the fauces). The **fauces** (forks) are formed by the anterior and posterior pillars of the soft palate, and the **isthmus of the fauces** is the narrow passage of the alimentary canal which is guarded by these pillars. It is the constricted portion between the mouth and throat, and should not be confounded with the latter.

The **lips** are two fleshy folds covered with integument, lined with mucous membrane, and containing the orbicularis oris (round of the mouth) muscle, blood-vessels (among these are the superior and inferior coronary arteries which are branches of the facial), nerves, areolar tissue, and numerous small labial glands. The inner surface of each lip is connected in the median line to the gum (gingiva, "to beget," because the teeth seem to be begotten in the gums) of the corresponding jaw by a fold of mucous membrane, called, respectively, the frænum labii superioris (bridle of the upper lip), and frænum labii inferioris (bridle of the lower lip).

The **labial glands** are situated beneath the mucous membrane of the lips, around the orifice of the mouth, and open by small orifices upon the mucous membrane. They are about the size of a small pea, and resemble the other salivary glands. The cheeks, in a similar manner, contain "buccal" and "molar" glands. The **cheeks** cover the sides of the mouth as the lips do the front. They contain within them several muscles, but the principal are the buccinator, masseter, and zygomatic. The mucous membrane lining the cheeks is reflected above and below upon the gums (gingivæ).

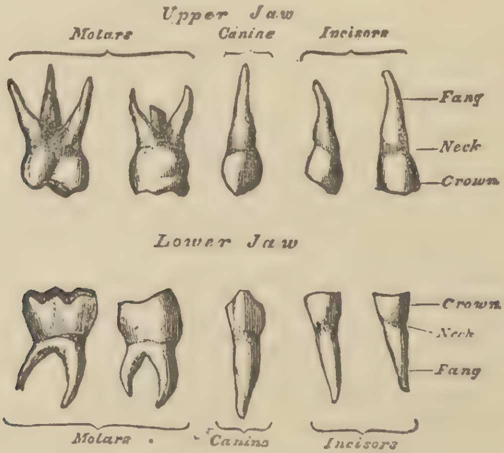
Opposite the second upper molar tooth is the minute opening of the duct of the parotid gland. (This duct is called Steno's duct, from Nicholas Steno).

The *gums* surround the necks of the teeth. They are composed of dense fibrous tissue closely connected to the periosteum of the alveolar processes. The gums are remarkable for their limited sensibility.

THE TEETH.

Two sets of teeth (dentes), and in rare instances three, are provided by nature. The first set, called *temporary, deciduous* (falling off), or *milk teeth,* appears in childhood; the second set appears, usually, between the seventh and twenty-first years, and when properly used and well cared for, continue to extreme old age. The second set is called the permanent set, or permanent teeth. There are 20 temporary and 32 permanent teeth, one half in each jaw. Each half of each jaw contains of the temporary teeth, commencing at the median line in front, 2 incisors (cutting), 1 canine (dog tooth), or cuspid (pointed), and 2 molars (grinding). The permanent set contains, in addition, 2 bicuspids (two points) and 1 molar.

Fig. 260.



THE TEMPORARY TEETH.

The temporary teeth are called deciduous (falling off), because they fall out. They are really pushed out, or removed, by the permanent teeth, which form in the jaw behind them. The temporary teeth begin to appear ordinarily about the seventh month, although in rare instances persons are born with teeth. The time of appearance is in general about as follows. Temporary set: incisors, seven to ten months; first molar, twelve to fourteen months; canine, or cuspid, fourteen to twenty

months; last molar, eighteen to thirty-six months. Permanent set: first molar, six and a half years; incisors, seven and a half; first bicuspid, nine years; second bicuspid, ten years; cuspids, or canine, eleven years; second molar, twelve years; third molar (called also wisdom tooth), seventeen to twenty-one years. The lower teeth generally appear somewhat earlier than the corresponding upper teeth. Each tooth consists of three portions — the **crown**, or **body**, which projects above the gum; the **root**, concealed in its socket (alveolus) beneath the gum; and the **neck**, which is the constricted portion between the other two. The incisors, cuspids, bicuspids, and molars all differ somewhat in character.

Fig. 261.

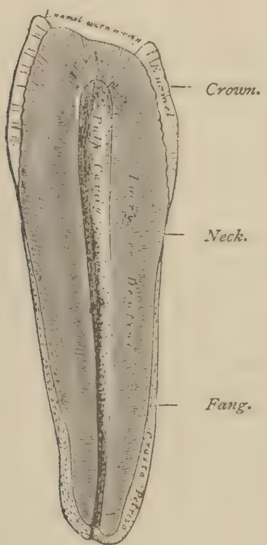
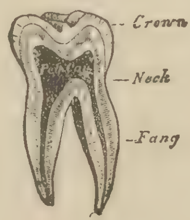


Fig. 262.



VERTICAL SECTION OF A BICUSPID AND A MOLAR TOOTH.
The latter is the natural size.

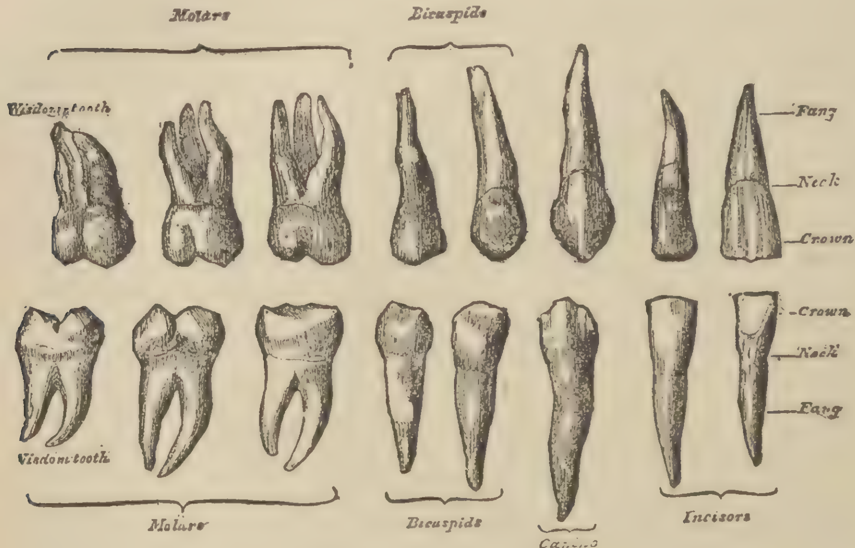
The **incisors**, eight in number, are the four front teeth in each jaw. They have a sharp, cutting edge, beveled on the posterior surface like a chisel, and one long, conical fang, or root. The incisors of the upper jaw are larger than those of the lower; and the two central are larger than those at the sides; while the two central of the lower jaw are smaller than the two lateral incisors.

The **cuspids** (having *one point*) are four in number, and are situated one on each side of the four incisors in each jaw. The crown tapers to a blunt point, which extends beyond the level of the other teeth. The root is longer and thicker than that of the incisors, but conical in form, and sinks deeply in the jaw.

The **bicuspids** (two points) are eight in number, two behind each canine in each jaw. The crown is surmounted by two pyramidal eminences (cusps, or points), separated by a groove. The root is generally single, but presents a tendency to become double, as is seen by the groove on each side. The apex of the root is often bifid, especially that of the second upper bicuspid.

The **molars** are twelve in number,—three placed behind each of the posterior bicuspids. The crown of each molar is nearly cubical in form, flattened in front and behind, and surmounted by cusps. The

Fig. 263.



THE PERMANENT TEETH.

first molar has usually five cusps; the second has four in the upper and five in the lower jaw; and the third, or last molar, has usually three cusps. The roots of the molars have usually **three fangs in the upper** and **two in the lower jaw.** The roots of the wisdom teeth are shorter, and slightly curved.

The **temporary teeth** resemble in form those of the corresponding permanent set. They lack the bicuspids and wisdom teeth. The fangs of the temporary teeth are generally more diverging from each other than those of the permanent teeth.

The apex of each fang, or root of the teeth, has a small aperture, which transmits blood-vessels and nerves to the **pulp cavity** at the base of the crown. The pulp cavity is filled with the dental pulp (chiefly vessels and nerves). The solid portion of the tooth consists of three

substances,— **dentine**, which forms the larger portion of the tooth; **enamel**, which covers the crown; and **cementum**, which forms a thin layer, resembling bone, on the surface of the fang. The **dentine** consists of a number of minute tubes (dental tubuli) imbedded in a dense homogeneous substance,— the intertubular tissue. The dental tubuli are placed parallel with one another, and open at their inner ends into the pulp cavity. The intertubular substance is translucent, finely granular, and contains the greater part of the earthy matter of the dentine. The earthy matter forms about 72 per cent of the dentine, consisting of phosphate and carbonate of lime, fluoride of calcium, and other salts. The animal matter is principally gelatine.

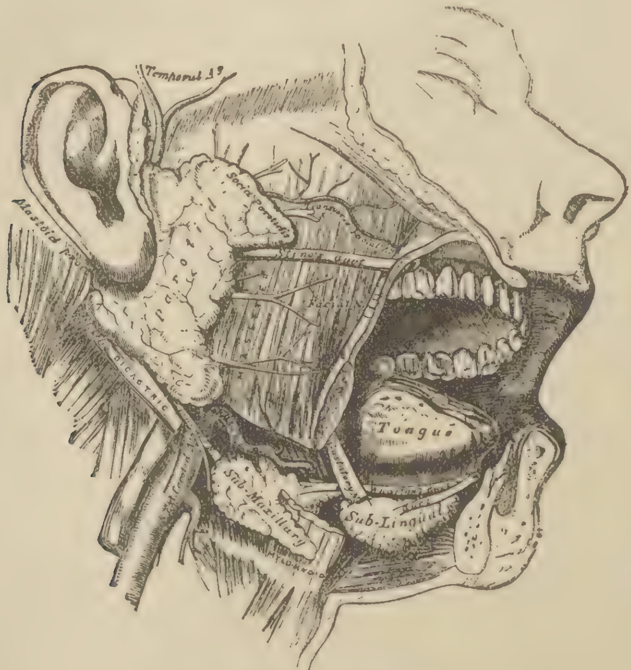
The **enamel** is the hardest part of the tooth. It consists of a congeries of minute hexagonal (six-sided) prisms, or rods, parallel with one another, one end resting on the dentine, the other forming the surface of the crown. The enamel is above 96 per cent earthy matter, and less than 4 per cent animal. The **cementum** (crusta petrosa, or rocky crust) covers the roots of the teeth. It much resembles bone, and is called, also, *cortical substance*. It increases in thickness as age advances, and sometimes forms a bony tumor, called "exostosis" (from the bone). The sockets (alveoli) of the teeth are lined with periosteum, which is reflected on the root of the tooth which it covers, and then unites with the fibrous structure of the gums.

The **palate** is the roof of the mouth. It consists of two portions,— the hard palate in front and the soft palate behind. The hard palate is formed of the palate processes of the superior maxillary and palate bones. The soft palate, or velum palati (veil of the palate), is a movable fold of mucous membrane suspended from the posterior border of the hard palate, and forming a septum (partition) between the back part of the mouth and the nasal fossæ (cavities of the nose). It contains muscular fibers, nerves, vessels, and mucous glands. The muscles of the soft palate are five on each side: the levator palati, tensor palati, palato-glossus, palato-pharyngeus, and azygos uvulæ. From the middle of the posterior border of the soft palate hangs the **uvula** (little grape), or uvule. This is a conical-shaped process of the soft palate, and contains the azygos uvulæ muscle. The name "azygos" (unmated) is inappropriate, as it is not a single muscle. Do not confound this pendulous body of the soft palate with the palate itself, which is the *roof of the mouth*. The **pillars** (or arches) **of the soft palate** are two folds of mucous membrane containing muscular fibers, and extending from the base of the uvule on each side, outward and downward, to the side of the base of the tongue. The two anterior pillars form one arch and the two posterior pillars the second arch. The anterior pillar on each

side contains the palato-glossus (palate and tongue) muscle, and the posterior pillar the palato-pharyngeus (palate and throat) muscle. The anterior and posterior pillars of the palate are separated below by a triangular interval on each side, in which the tonsil is lodged.

The **tonsils**, or amygdalæ (almonds), are two glandular bodies, situated one on each side of the isthmus faucium ("isthmus of the fauces," or strait which connects the mouth and throat). Each tonsil has twelve or fifteen apertures upon the mucous surface, and lies in close relation to the internal carotid artery.

Fig. 264.



THE SALIVARY GLANDS.

The principal **salivary glands** are the parotid (near the ear), the submaxillary (under the jaw), and the sublingual (under the tongue)—three pairs. The **parotid** is the largest, and weighs over half an ounce (sixteen grams). It lies immediately below and in front of the external ear-passage, behind the margin of the ramus (branch) of the lower jaw, and extends deeply into the neck by two large processes, one behind and the other in front of the styloid process of the temporal bone. Important blood-vessels and nerves pass through its substance, and the largest artery and vein of the neck lie close to its deeper sur-

face. The facial nerve, which governs nearly all the muscles of expression, as it emerges from the stylo-mastoid foramen, runs forward in the substance of this gland; and the external carotid artery, with its terminal branches (temporal and internal maxillary), is imbedded within it. The *duct of the parotid gland* (Steno's duct — named from Nicholas Steno) is about the size of a crow-quill. It is about six centimeters (two and one-half inches) in length, and extends from the anterior border of the gland across the masseter muscle through the buccinator to the inner surface of the cheek, where it opens into the mouth by a small orifice opposite the second molar tooth of the upper jaw. The **submaxillary** (under the jaw) **gland** is situated below the jaw in the anterior part of the submaxillary triangle of the neck. It is covered by the body of the lower jaw on each side, and is separated from the parotid gland by the stylo-maxillary ligament. Its secretion is carried into the mouth by Wharton's (Thomas Wharton) duct, which is about five centimeters (two inches) in length, and opens by a narrow orifice at the side of the frænum linguæ (bridle of the tongue).

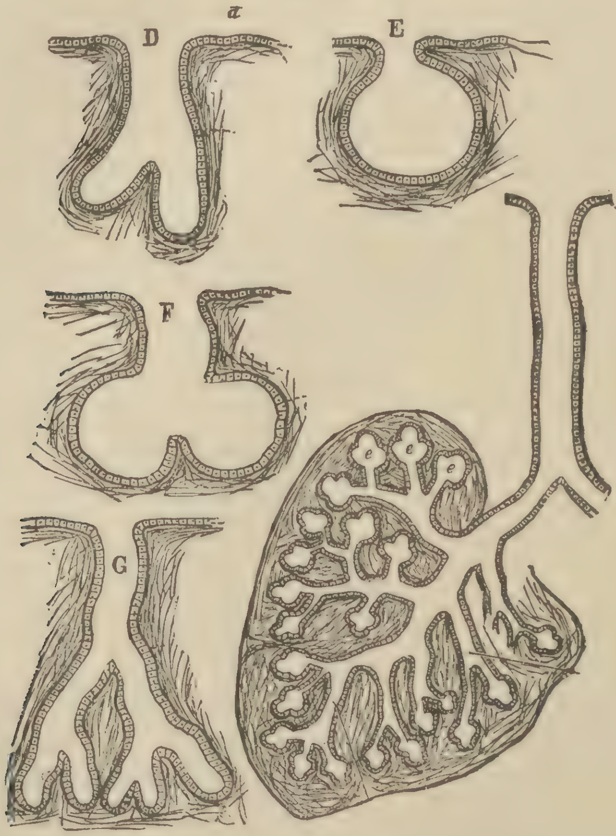
The **sublingual gland** is the smallest of the three salivary glands. It is situated beneath the mucous membrane of the floor of the mouth, on both sides of the frænum linguæ, in contact with the inner surface of the lower jaw, and close to the symphysis menti ("union of the chin" — median line in front, where the two sides of the lower jaw unite). Its ducts, eight to twenty in number, nearly all open separately into the mouth beneath the tongue, but one or more open into Wharton's duct by one united tube (duct of Bartholine).

The salivary are conglomerate (formed of small glands) glands, connected by areolar tissue, vessels, and ducts (canals, or tubes, through which fluids are conveyed).

The **pharynx** (throat) is the *common passage* for aliment and air. It is that part of the alimentary canal situated behind the nasal fossæ, isthmus faucium, and larynx. Its upper part has been called the sinus of Morgagni (pronounced Mor-gän-yee). The pharynx is a membranous sac, about eleven centimeters (four and one-half inches) in length, extending from the under surface of the skull to the cricoid (ring-like) cartilage of the larynx opposite the fifth cervical vertebra. It is limited above by the basilar process of the occipital bone; below, it opens into the œsophagus (gullet); posteriorly, it lies against the bodies of the five upper vertebræ; anteriorly, it is incomplete, and its walls are attached to the pterygoid (wing-like) processes of the sphenoid bone, lower jaw, tongue, hyoid bone, and larynx; at the sides its walls are connected to the styloid processes of the temporal bone, and are in contact with the common and internal carotid arteries, the internal jugular veins, and with cranial and sympathetic nerves.

The pharynx has seven openings: the two posterior nares (nostrils), the two Eustachian tubes, the isthmus faucium, the larynx, and the œsophagus. The posterior nares open into the nasal fossæ (cavities of the nose); the Eustachian tubes into the tympana (drums, or middle ears); the isthmus faucium into the mouth; the larynx into the lungs; and the œsophagus into the stomach. The uvula, the base of the tongue, and the epiglottis, form part of the anterior wall of the pharynx.

Fig. 265.



FORMS OF GLANDS.

D. and G. Tubular Glands.
E. A simple Racemose Gland.
F. A compound Racemose Gland.
a. The Epithelial Layer.
e. One of the simple Racemose Glands.

One half of a highly developed racemose gland is seen upon the right.

The pharynx has three coats—the mucous, fibrous, and muscular. The muscular coat comprises five muscles—the three (superior, middle, and inferior) constrictors of the pharynx, the stylo-pharyngeus, and the palato-pharyngeus.

The fibrous coat is situated between the mucous and muscular layers, and is called the "**pharyngeal aponeurosis**." This aponeurosis is firmly connected to the basilar process of the occipital bone, and to the petrous portion of the temporal.

The mucous coat is the interior, or inner coat, and is covered by columnar ciliated epithelium, as low down as a level with the floor of the nasal cavities; below that it is of the squamous (scaly), or pavement variety, which lines the mouth and isthmus. The mucous coat, or membrane, of the pharynx is supplied with glands (the pharyngeal) of two varieties — the simple follicular (a simple sac), and the racemose (in clusters, like grapes).

The **œsophagus** (food-carrier, or gullet) is a membranous canal about twenty-two centimeters (nine inches) in length, extending from the pharynx (throat) to the stomach. It commences at the lower border of the cricoid (ring-like) cartilage of the larynx, descends along the front of the spine through the posterior mediastinum (space between the lungs), passes through the diaphragm with the pneumogastric nerves, a little in front of the aorta, and terminates in the abdomen at the cardiac orifice of the stomach, opposite the ninth dorsal vertebra.

The coats of the œsophagus are similar to those of the pharynx. The outer muscular coat is composed of two planes of fibers — external longitudinal, and internal circular fibers. The muscular fibers of the upper part of the œsophagus are striped, like the voluntary muscles, but below they are involuntary fibers.

The mucous membrane which lines the œsophagus is continuous with the mucous membrane of the pharynx. It is covered with a thick layer of squamous epithelium (a layer of overlapping scales, or flattened cells). Some glands (the œsophageal) are found beneath the mucous surface.

The **abdomen** (concealer, because it conceals the viscera) is the largest of the three splanchnic cavities,—(cranial, chest, and abdomen). The abdomen is also called the "venter" (belly), or "alvus"; hence "alvine" relates to the abdomen.

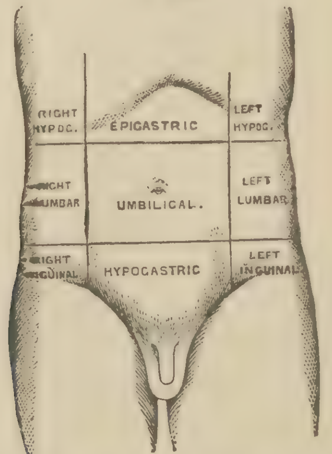
The abdomen is bounded above by the diaphragm and below by the brim of the pelvis, although some authors include the pelvis in the abdomen. This great splanchnic (visceral) cavity (the abdomen) contains the stomach, the small and large intestine, liver, spleen, pancreas, kidneys, supra-renal capsules, the omenta, the mesenteric glands, arteries and veins, the abdominal aorta, the inferior vena cava, and numerous other glands, vessels, and nerves.

In the abdominal walls are eight openings; and if we include the pelvis, we shall have ten openings in the male and eleven in the female.

Three of these openings are upward, through the diaphragm ; one (the aortic) transmits the aorta, vena azygos, and thoracic duct ; a second (the œsophageal) transmits the œsophagus and the pneumogastric nerves ; and the third (**the caval**) transmits the inferior vena cava. Five of the abdominal openings are in its anterior walls : one (the umbilicus) is in the median line of the body, and transmits in fœtal life the two umbilical arteries and the umbilical vein, but becomes closed soon after birth by the obliteration of these vessels ; and two are in each groin (the inguinal and femoral canal).

The inguinal canal transmits the spermatic cord in the male, and the round ligament in the female ; and the femoral canal transmits lymphatic vessels to a lymphatic gland which generally occupies the femoral ring. The inguinal canal is *above* Poupart's ligament, the femoral, below.

Fig. 266.



THE NINE REGIONS OF THE ABDOMEN.

The **femoral** (or crural) **canal** is one or two centimeters (about half an inch) in length, and *extends from the femoral ring above to the saphenous opening below.* The femoral ring is closed by the septum crurale, and the saphenous opening by the cribriform fascia ; hence a femoral hernia (protrusion of the bowel, or some part of the abdominal viscera) is covered by these two membranes in addition to others.

In the floor of the pelvis are two abdominal openings in the male, and three in the female. These are the urethral, rectal, and in the female the vaginal, leading, respectively, into the bladder, rectum, and uterus.

The abdomen is artificially divided into **nine regions**, by two vertical and two horizontal planes. The vertical planes extend upward, on

either side, from the middle point of Poupart's ligament; and the horizontal are so drawn that the lower touches the crests of the ilia (plural of ilium), and the upper cuts the cartilages of the ninth pair of ribs. The regions thus limited are, on either side from above downward, the two hypochondriac, two lumbar, and two iliac (or inguinal) regions; and in the middle, the epigastric, umbilical, and hypogastric.

Epigastric signifies "upon (or over) the stomach;" and hypogastric, "under the stomach." The hypogastric region is also called the pubic region, because it is in the region of the pubic bone. Hypochondriac signifies "under the cartilage," having reference to the costal (rib) cartilages. Inguinal relates to the groin (depression between the belly and thigh); and lumbar to the loin (the posterior region of the abdomen between the chest and pelvis).

According to this artificial, or conventional division of the abdomen, the stomach lies chiefly in the epigastric region, although the splenic (or cardiac [near the heart]) end of the stomach may reach, when the stomach is distended, the left hypochondriac region. The main part (right lobe) of the liver lies in the right hypochondriac region, but the left lobe of the liver extends into the epigastric region. The supra-renal capsules lie in the hypochondriac regions, but the kidneys lie partly in the hypochondriac and partly in the lumbar regions. The **semilunar ganglia** are in the epigastric region on either side of the cœliac axis. The **cœcum** is in the right iliac (or inguinal) region, and the sigmoid flexure of the colon in the left iliac (or inguinal) region. The two intestines (large and small) extend into all the abdominal regions.

The **peritoneum** (stretched around) is a serous membrane which lines the abdominal cavity, and largely invests the viscera that fill it. It corresponds to the pleura of the chest, and forms numerous prolongations, reflections, folds, and ligaments, that serve to connect the abdominal organs to each other, and also to the walls of the abdomen.

Any fold, or prolongation, of the peritoneum which connects the *stomach* with an adjoining organ, takes the name of **omentum, caul,** or **epiploon.** The latter term signifies something that sails, or "floats upon," and is particularly applicable to the great omentum which floats upon (in front of) the folds of the small intestine. There are three omenta (or epiploa). These three connect the stomach (gaster) with the colon, spleen, and liver, and are named, respectively, the gastro-colic, gastro-splenic, and gastro-hepatic omentum. The *gastro-colic* (stomach and colon) is the **great omentum,**—the largest peritoneal fold. In the young subject it consists of four layers, two of which descend from the stomach (one from its anterior, the other from its

posterior surface) in front of the small intestine as low down as the pelvis; then doubling upon themselves, ascend to the transverse colon, which they inclose. In the adult these four layers (two layers doubled upon themselves) are more or less intimately blended, and contain some adipose (fatty) tissue, which, in fat subjects, may accumulate in considerable quantity. The omentum protects the intestine from cold, and facilitates its movements.

Fig. 267.

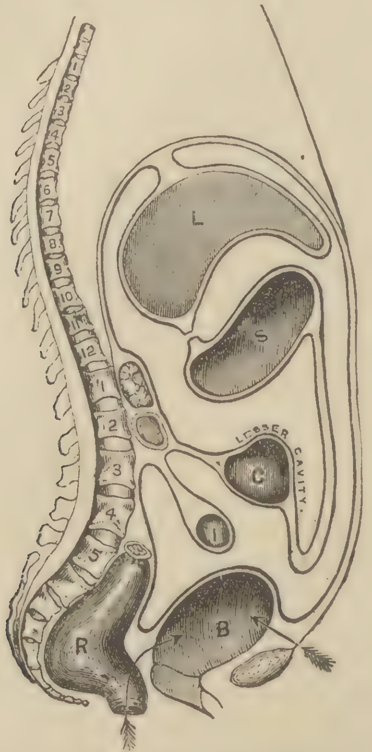


DIAGRAM OF THE PERITONEUM.

L. Liver. C. Colon. B. Bladder.
S. Stomach. I. Small Intestine. R. Rectum.

The arrows indicate surgical positions for puncturing the distended bladder.

The **gastro-splenic** (stomach and spleen) omentum connects the spleen to the left extremity (the greater, or splenic end, called, also, the cul-de-sac, or fundus) of the stomach, and contains the splenic vessels (artery and vein).

The **gastro-hepatic** (stomach and liver) omentum (the lesser omentum) connects the transverse fissure of the liver with the lesser curva-

ture (upper part) of the stomach, and forms Glisson's capsule (a dense membrane surrounding the portal vein and its ramifications in the liver, and named from Francis Glisson).

The **mesentery** and the mesocolon are also folds of the peritoneum. The mesocolon is divided into the mesocæcum, ascending, transverse, and descending mesocolon, sigmoid mesocolon, and mesorectum. The terms designate the *parts connected*. The *mesentery* (middle of the intestine) connects the middle line of the cylinder of the *small intestine* (jejunum and ileum) with the posterior wall of the abdomen, while the mesocolon connects the various parts of the colon, or *large bowel*, to the walls of the abdomen and pelvis.

The **root of the mesentery** (the part attached to the vertebral column) is about fifteen centimeters (six inches) in length, and extends across the body of the second lumbar vertebra to the right sacro-iliac symphysis (union of the sacrum with the ilium); its other border which incloses the intestine, is much longer. Its breadth between its vertebral and intestinal border, is about ten centimeters (four inches).

The mesentery serves to retain the small intestine in position (in situ), and contains between its layers the mesenteric vessels, nerves, glands, and lacteals (lymphatic vessels, that carry chyle).

Other folds of the peritoneum **form ligaments** for the attachments of the liver, spleen, uterus, and bladder. Four of the five ligaments of the liver, one of the stomach (the gastro-phrenic, attaching the stomach to the diaphragm), five of the bladder (the five false ligaments), the six ligaments of the uterus (two in common with those of the bladder), and the suspensory ligament of the spleen (connecting it with the diaphragm), making eleven of the male and fifteen of the female, are all peritoneal folds.

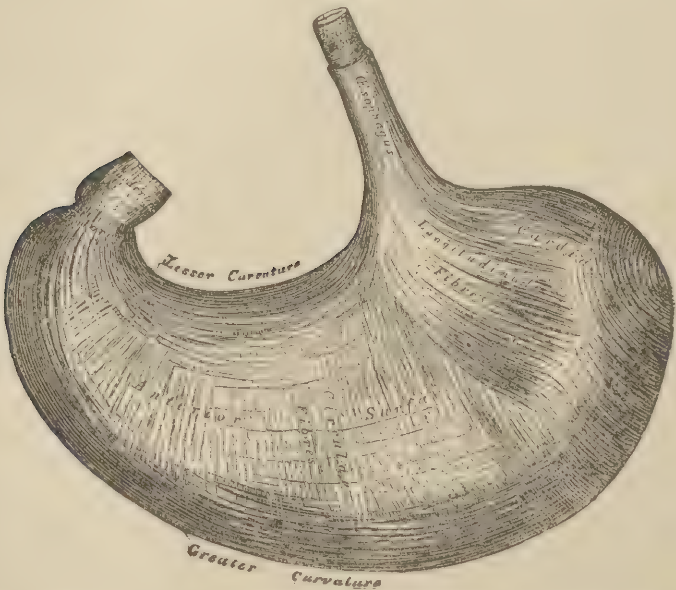
Many of the abdominal viscera are almost entirely covered with the visceral portion of the peritoneum, while others are only partially covered. The lower part of the rectum and anterior portion of the bladder are not covered with peritoneum. The kidneys and pancreas, also, receive no special investment.

The space between the visceral (investing the viscera) and parietal (lining the abdominal walls) portion of the peritoneum is called the **peritoneal cavity.** This general cavity is constricted at a part called the foramen of Winslow, which is said to connect the greater and lesser peritoneal cavity. The opening is large enough to admit the finger. (See Fig. 267.)

The free surface of the peritoneum, which forms the wall or lining of the peritoneal cavity, is smooth and moist, and is covered by a thin, squamous epithelium.

The **stomach** (Greek, "gaster") is the most dilated part of the alimentary canal, and the principal organ of digestion. It is situated in the abdomen, just below the liver, and chiefly in the epigastric region. **It has two ends, two curvatures, and two orifices.** The ends are the greater and lesser; the curvatures are also the greater and lesser, and two of its omenta are the greater and lesser; but the orifices are the cardiac and pyloric (gate-keeping). The greater end is on the left, toward the spleen, and is sometimes called the splenic end, or fundus (bottom) of the stomach. The **pyloric orifice** is at the lesser end, and opens into the duodenum, the aperture being guarded by a valve, or sphincter muscle. The **cardiac orifice** opens into the

Fig. 268.



THE MUSCULAR COAT OF THE STOMACH, SHOWING THE DIRECTION OF THE FIBERS.

stomach from the œsophagus, and is shaped something like a tunnel placed bottom upward. It is situated near the middle of the upper border of the stomach, but somewhat nearer the greater end, so that the lower border of the stomach, extending from the pyloric orifice round the greater end of the stomach to the cardiac orifice, forms the greater curvature; while the upper border, extending to the inner sides of the same orifices, forms the lesser curvature. The upper border (or lesser curvature) of the stomach is connected to the under surface of the liver by the lesser (gastro-hepatic) omentum; and the lower

border (the greater curvature) gives attachment to the great omentum (gastro-colic), which connects the stomach to the transverse colon.

The principal coats of the stomach are the serous, muscular, and mucous. · A fourth coat, called the submucous (under the mucous), or vascular coat, consists of areolar tissue, and connects the mucous and muscular coats. The submucous coat gives support to the blood-vessels distributed to the inner mucous coat, and also gives more firmness for the action of the muscular coat, which would otherwise act directly upon the inner mucous coat (or mucous membrane).

The **serous coat** of the stomach forms its outer surface. It is derived from the peritoneum, and covers both the anterior and posterior surfaces of the stomach, but leaves a small triangular space uncovered, along the upper and lower borders (the lesser and greater curvatures), along which the nutrient vessels and nerves pass to this organ.

The **muscular coat** is situated between the serous (outer) coat and the areolar tissue (the vascular, or submucous coat), which separates it from the mucous coat. The outer part of the muscular coat consists of longitudinal fibers, which are continuous with the longitudinal fibers of the œsophagus and small intestine; while the inner fibers of the muscular coat are circular, and are most abundant at the pyloric orifice, where they are aggregated into a ring, and form the pyloric valve. Besides these two sets of muscular fibers, there is, on the cardiac end of the stomach, a thick uniform layer of oblique fibers, some passing from left to right, others from right to left around the cardiac orifice. It is by the action of the muscular fibers that the food is moved and mixed with the gastric (stomach) juice.

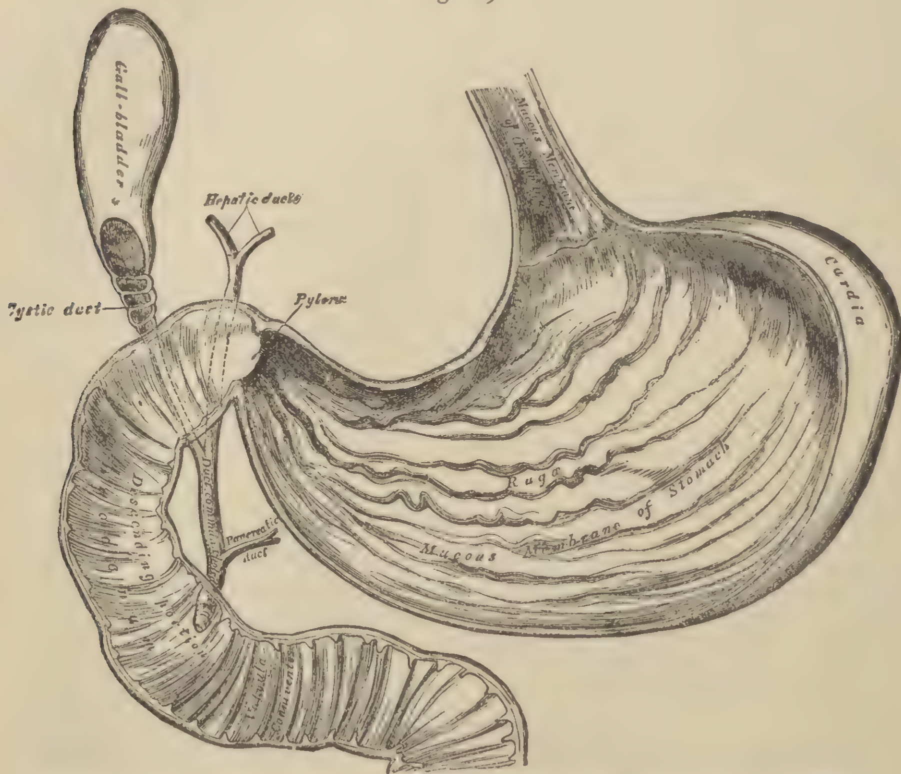
The **mucous coat** (more commonly called "mucous membrane") of the stomach is the inner coat. It is thick, smooth, soft, and velvety. During the contracted state of the organ it is thrown into numerous plaits, or wrinkles (rugæ), which become obliterated when the organ is fully distended. Examined with a lens, the free surface of the mucous membrane appears like a honey-comb, on account of numerous polygonal ("many angles" and sides) depressions, or small cavities (alveoli), which vary in diameter from .025 centimeters ($\frac{1}{100}$ of an inch) to .007 centimeters ($\frac{1}{350}$ of an inch). In the bottom of each little cavity (alveolus) are seen several minute openings (the orifices of the gastric follicles [small bags]). Some of the **gastric follicles** are simple tubes; others are convoluted, branching, and saccate. These follicles, or tubules, perpendicular to the free surface of the mucous membrane, form, or constitute, the mucous and peptic (digestive) glands. They are all lined with columnar (columns, or prismatic cells standing on end) ciliated (having fine hairs) epithelium. Epithelium (upon the

nipple) is a term applied to a thin layer of cuticle, which covers parts deprived of true skin, like the nipple and mucous membranes.

The nerves of the stomach are the terminal branches of the right and left pneumogastric, and branches from the sympathetic system.

The next portion of the alimentary canal, below the stomach, is the small intestine (bowel), divided into the duodenum, jejunum, and ileum. It is a convoluted tube, about six meters (twenty feet) in length, contained in the central and lower parts of the abdomen and pelvis, and surrounded above and at the sides of the abdomen by the large intestine (bowel), or colon.

Fig. 269.



MUCOUS MEMBRANE OF THE STOMACH AND DUODENUM, WITH THE BILE DUCTS.

The **duodenum** ("twelve" fingers' breadth in length) is the shortest and most fixed part of the small intestine. It is about twenty-five centimeters (ten inches) long, has no mesentery, and is only partially covered by the peritoneum. The duodenum, something like the arch of the aorta and colon, is divided into an ascending, descending, and transverse portion; but, unlike them, the transverse portion is not the

second, but the third portion of the duodenum. Commencing at the pyloric orifice (or simply pylorus [gate-keeper]), the duodenum first ascends obliquely upward and backward to the under surface of the liver and neck of the gall bladder; then descends in front of the right kidney, embraces the head of the pancreas, receives the common bile and pancreatic ducts; and turning to the left, below the head of the pancreas, passes across the front of the spinal column, terminating in the jejunum, on the left side of the second lumbar vertebra. The second (or descending) portion is firmly fixed by the peritoneum and pancreas. The common bile duct and pancreatic duct enter this portion of the duodenum. The transverse portion rests upon (in front of) the aorta, the vena cava, and the crura of the diaphragm, and beneath (or behind) the superior mesenteric artery and vein. The nerves of the duodenum are traced to the solar plexus. **Brunner's glands** are found in the duodenum and in the commencement of the jejunum. These glands, in structure, resemble the pancreas, and are most numerous and largest near the pylorus (gate-keeper).

The **jejunum** (hungry) includes two fifths or more of the rest of the small intestine (or bowel). Its convolutions are confined, chiefly, to the umbilical and left iliac regions. There is no mark to distinguish its termination from the commencement of the ileum.

The **ileum** (twisted, or coiled), so called from its numerous coils or convolutions, includes the lower portion of the small bowel. It occupies chiefly the umbilical, hypogastric, right iliac, and, occasionally, the pelvic regions, and terminates in the right iliac fossa by opening into the lower part of the ascending colon at the ileo-cæcal valve. The coats of the small intestine correspond in number and name to those of the stomach. They are the serous, muscular, alveolar, and mucous. The serous coat is derived from the peritoneum (that part of it called the mesentery); the muscular has longitudinal and circular fibers, which produce the vermicular motion of the bowels; the alveolar (or submucous coat) gives firmness to the intestinal wall, and forms a nidus (nest) for the subdivision of nutrient vessels previous to their distribution to the inner mucous membrane. The free surface of the mucous membrane is covered with columnar epithelium.

The **valvulæ conniventes** (little shutting valves) are folds, or reduplications, of the mucous membrane and submucous tissue, jutting into the cavity of the intestine. They serve to retard the passage of food along the bowels, and afford a much more extensive surface for the lacteal vessels (lymphatics, or absorbents). They are large, and most numerous in the jejunum and lower part of the duodenum; and the same may be said of the villi (papillæ of the bowel),

although the *villi* (plural of villus) are found on the surface of the mucous coat throughout the small intestine; while the valvulæ conniventes are not found very near the pylorus nor at the lower part of the ileum. Krause estimates the number of villi at four million — about twice the number of pores in the skin. These estimates of the number of pores and villi are only rough approximations to the truth.

Each **villus** (papilla of the bowel) consists of a network of capillary and lymphatic (here called "lacteal") vessels inclosed in a thin membrane, and covered by columnar epithelium. The mode of origin of the lacteal within the villus is unknown. Scattered among the villi are the minute orifices of the **follicles of Lieberkuhn** (pronounced Lee-ber-koon). Their use is unknown.

The **solitary glands** are scattered throughout the mucous membrane of the small intestine, but are most numerous, as are also **Peyer's glands** (Conrad Peyer), which are aggregations, or patches, of solitary glands, in the lower part of the ileum. These glands resemble in structure and function the spleen, thyroid, and supra-renal glands. They are small, round, whitish bodies about two tenths of a centimeter (one twelfth of an inch) in diameter, consisting of a closed cavity containing a white secretion, but having, so far as is known, no excretory duct. Peyer's glands, or patches (twenty to thirty in number), are an aggregation of these glands in a single oval or circular patch. The use of these ductless glands is unknown.

The colon (limb, or member), **or large intestine,** is the large bowel, and forms the lower part of the *intestinal* canal. The alimentary canal opens into it, as into a common sewer. The entrance is guarded by the ileo-cæcal valve. The intestinal (intus, "within") canal may include both the large and small intestine, but the term alimentary (nourishing) canal is not applicable to the large intestine, whose function is excretory. The large intestine is called in general the colon, but is divided, more particularly, into the cæcum, ascending colon, transverse colon, descending colon, sigmoid flexure, and rectum. These divisions depend chiefly upon the form and direction of the tube, or canal, which constitutes the colon.

According to some authors, the colon is the part of the large intestine included between the cæcum and rectum; but the signification of colon (limb, or member) makes it applicable alike to the *cæcum and rectum*. One author derives colon from a Greek word signifying "hollow," and another from a word signifying to "retain," thinking it refers to the retention of the ingesta of the large bowel for some time before it is discharged. Either of these two definitions — "hollow," or "retain" — applies with equal force to one part of the large

bowel as to any other part. The derivation which is first mentioned — "limb" — seems to mark the fact that the large intestine joins the small, as a limb joins the body, at an angle. And taking into consideration the general appearance of these parts, and their manifest similarity of form and function (office), we cannot find any good reason for limiting the colon to the middle part of the large bowel, but must extend it so as to include the cæcum and rectum as beginning and end. The colon is so fixed in position as to describe an arch which very nearly surrounds the convolutions of the small intestine. It commences in the right iliac fossa (near the right groin); ascends in front of the

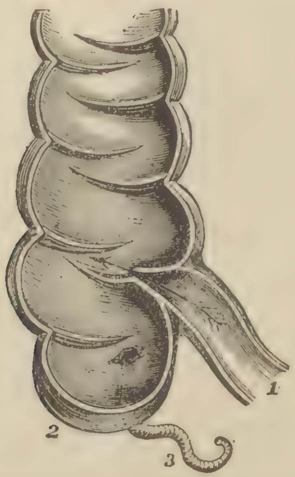
Fig. 270.

THE CÆCUM AND COLON, LAID OPEN TO SHOW THE ILEO-CÆCAL VALVE.

right kidney to the under surface of the liver, on the right of the gall bladder; bends abruptly inward to the left, forming the hepatic (liver) flexure; passes transversely across the abdomen, describing an arch (transverse arch of the colon) in front of the vertebral column; reaches the lower end of the spleen; curves downward, forming the splenic (spleen) flexure; descends almost vertically in front of the left kidney to the upper part of the left iliac fossa; forms a curve like the letter S (the sigmoid flexure), enters the pelvis obliquely on the left of the median line, curves forward on the anterior concave surface of the sacrum and coccyx, and near the extremity of the coccyx inclines

somewhat backward to terminate at the anus. The term "anus" signifies "a circle," and is applied to the circular opening at the lower extremity of the large intestine, which is called the "rectum" (straight). The rectum is not straight, however. It inclines (if we take the upward direction from the lower extremity), at first, slightly forward, till we reach the end of the coccyx; then backward, along the concavity of the coccyx and sacrum, to the middle of the sacrum, where it turns obliquely to the left, to join the sigmoid flexure. Having traced the colon as a whole, we shall now describe its several parts more particularly. Its entire length is about one and a half meters (five feet).

Fig. 271.



COMMENCEMENT OF THE COLON.

1. The Ileum. 2. The Cæcum. 3. The Appendix Vermiformis.

The **cæcum** (blind, because it is open only at one end) is that part of the large bowel, or colon, which lies below the ileo-cæcal valve at the commencement of the ascending colon in the right iliac fossa, immediately behind the anterior abdominal wall, being retained in its place by the peritoneum (here called the mesocæcum). Attached to the lower and back part of the cæcum, and opening into it, is a long, narrow, worm-shaped (vermiform) tube, or appendix, about the size and length of the tubular part of a goose-quill. It is the relic of the longer cæcum, usually found in the lower mammalia (animals that suckle their young).

The **ileo-cæcal valve** is situated at the junction of the small intestine with the large, and is so constructed of folds of membrane as to allow any refuse or foreign matter of the small intestine to enter the

colon (large bowel); but prevent, *ordinarily*, the ingesta (substances "borne in") of the large bowel from entering the ileum (small bowel). This valve is about six centimeters (two and a half inches) above the commencement of the large bowel, in the right iliac fossa; or in other words, the small intestine enters the large about six centimeters (two and one-half inches) above its commencement. In cases of long and severe vomiting, the ileo-cæcal valve yields to the reversed action.

From the cæcum the large bowel (here called the *ascending colon*) passes up to the under surface of the liver, where it forms the hepatic (liver) flexure, and becomes from this point the transverse colon. At the hepatic flexure the colon is connected by loose areolar tissue to the right quadratus lumborum (square of the loins) muscle and right kidney, which lie behind it.

The **transverse colon** passes from right to left across the abdomen, between the epigastric and umbilical regions to the lower end of the spleen, where it curves downward (forming the splenic flexure) and becomes the descending colon. As it passes the spinal column from right to left, it curves in front of the bodies of the vertebræ, forming the **transverse arch of the colon.** This part of the colon (the transverse) is in relation, or connection, by its upper surface, with the liver, gall bladder, stomach, and lower end of the spleen, and by its under surface with the folds of the small intestine.

The **descending colon** extends from the splenic flexure through the left lumbar region to the sigmoid flexure in the left iliac fossa. It is smaller, and more deeply placed, than the ascending colon. Its posterior surface is connected by areolar (or connective) tissue with the left kidney and left quadratus lumborum muscle. The **sigmoid flexure** extends from the margin of the crest of the ilium (part of the hip bone) to the left sacro-iliac symphysis (junction, or union of the sacrum and ilium), where it becomes the rectum. At first this flexure curves upward, then descends toward one side. It is retained in place by a loose fold of peritoneum. The **rectum** ("straight," although it curves with the sacrum, and also passes obliquely downward and inward from the left side toward the median line) is the terminal part of the large intestine. It is fifteen or twenty centimeters (about seven inches) in length, and for more minute description, is divided into three portions, lower, middle, and upper. The *upper portion* comprises about half its length, and extends obliquely from the left sacro-iliac (sacrum and ilium) symphysis to the center of the sacrum, to which it is connected by the peritoneum (here called the meso-rectum). It lies behind the bladder, and in front of the pyriform muscle and sacral plexus of nerves. In the female the upper portion of the rectum lies closely behind the

uterus, which separates it from the bladder in front. The *middle portion* is six or seven centimeters (about two and a half inches) in length, and extends to the tip of the coccyx, closely connected to the concavity of the sacrum. It lies just behind the base of the bladder, the seminal vesicles (vesiculæ seminales), and the vasa deferentia ("outward bearing vessels," meaning the spermatic ducts). In the female this portion of the rectum (the middle portion) adheres to the posterior wall of the vagina. The *lower portion* of the rectum is two or three centimeters (about an inch) in length. It extends from the tip of the coccyx to the anus, and curves backward as it descends. It is invested by the internal sphincter muscle, and surrounded at its termination by the external sphincter ani. A triangular space separates the lower portion of the rectum from the membranous portion and bulb of the urethra in the male, and from the vagina in the female. This space is filled by perineal muscles and fasciæ. The rectum is not sacculated (divided into sacs, or compartments) like the rest of the large intestine.

The large intestine, like the small, and the stomach, has, in general, four coats — serous, muscular, areolar (sub-mucous, or vascular), and mucous. The latter differs essentially from that of the small intestine. The *serous coat* is derived from the peritoneum, which is the serous membrane of the abdomen, and does not cover any portion of the alimentary canal above the diaphragm. In the abdomen it does not completely cover all the different portions of the intestinal canal. The cæcum, ascending and descending colon, and the middle portion of the rectum, are covered by this coat only in front; and the *lower portion* of the rectum is entirely devoid of any serous covering. Pouches of peritoneum, filled with fat, along the colon and upper part of the rectum, are termed "appendices epiploicæ" (appendages of the epiploon). The muscular coat has longitudinal and circular fibers. It is the longitudinal fibers that give to the upper parts of the colon their peculiar sacculated character. When the tube is lengthened, or the longitudinal fibers are dissected off, the sacculated character of the tube becomes lost. The circular fibers are especially accumulated in the intervals between the sacculi (little sacs); and in the lower portion of the rectum they become numerous, and form a thick layer — the internal sphincter (the constrictor muscle) of the anus.

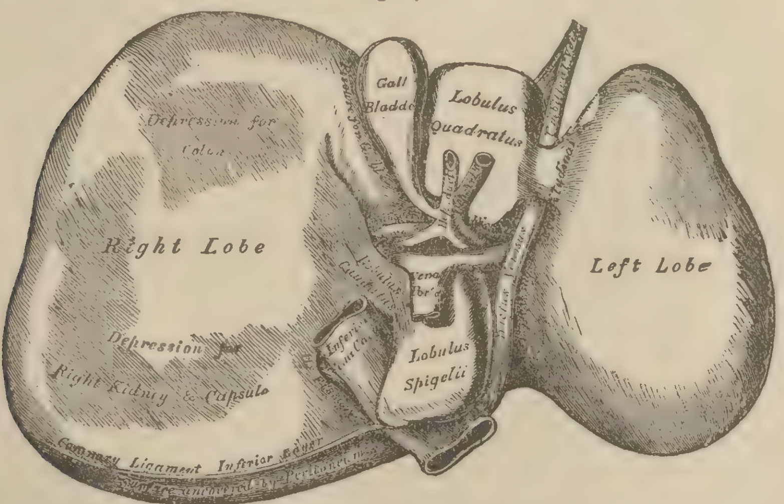
The *mucous membrane* (or mucous coat) of the large intestine is destitute of villi (papillæ), — another convincing proof that this part of the so-called alimentary canal is not properly alimentary, but excretory. The alimentary canal terminates properly at the ileo-cæcal valve: the large bowel is different altogether. It is the main sewer of solids and semisolids. The *simple follicles* (little bags, or crypts) of Lieberkuhn

(pronounced Lee-ber-koon') are very numerous in the colon (large intestine), over its entire surface. They are secreting cavities, that open by small orifices into the large intestine. The colon is several times larger than the small intestine; is sacculated; and its mucous surface is marked with orifices of numerous tubular glands, which may be traced to the margin of the ileo-cæcal valve, but not above it. They are not found in the membrane of the small intestine, or alimentary canal. The relative length of the colon to the small intestine is as one to four; but, owing to its greater capacity, the extent of surface of the mucous membrane is about the same in both.

THE LIVER.

The liver is the *largest gland* in the body. It is situated in the right hypochondriac and epigastric regions, in direct contact with the under surface of the diaphragm, and weighs, ordinarily, about the same as the brain,—three or four pounds. It is an organ of fives, having five lobes, five ligaments, five fissures, and five sets of vessels.

Fig. 272.



THE UNDER SURFACE OF THE LIVER.

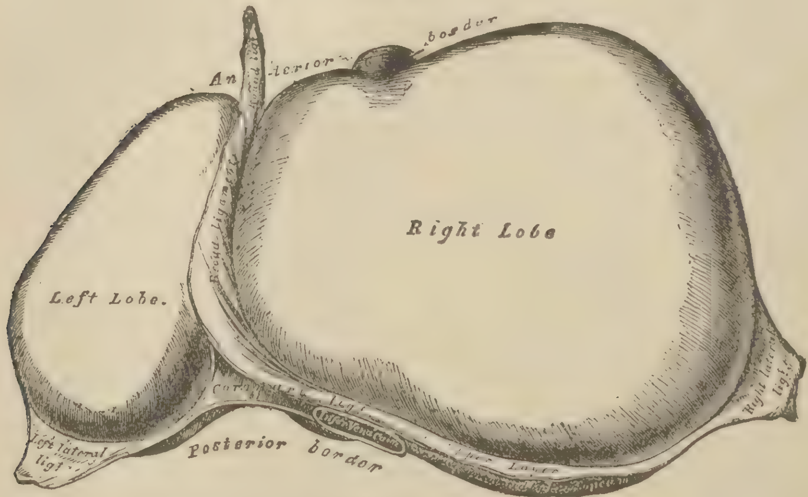
The ligaments are the suspensory (longitudinal, or broad), the right and left lateral, the coronary, and the round (called also the ligamentum teres). The five lobes are the right, left, square, caudate, and lobus Spigelii (lobe of Spigelius). The upper surface of the liver presents but two lobes (the right and left); the other three are really parts of the right lobe, and can be seen only on the under surface.

The fissures are the longitudinal, transverse, cystic (for the gall bladder), caval (for the vena cava), and the venous duct fissure. The latter is really a part of the longitudinal fissure upon the under surface of the liver.

The five sets of vessels are the hepatic duct, artery, and vein, the portal vein, and the lymphatics.

The **right lobe** of the liver comprises at least five sixths of the entire organ. It is not only much thicker, being about seven centimeters (or three inches) at the back part, but it is broader and longer than the left lobe; so that we may say that the main portion of the liver lies in the right hypochondriac region. The right lobe is divided

Fig. 273.



UPPER SURFACE OF THE LIVER.

from the left, on the upper surface, by the longitudinal (broad, or suspensory) ligament, and on the lower surface by the round ligament and longitudinal fissure. At the anterior border of the liver these two ligaments unite; the round ligament, which runs along the longitudinal fissure on the under surface, being contained between the layers of the **broad** (longitudinal, or suspensory) **ligament** that runs along the upper surface. The broad ligament suspends the liver from the under surface of the diaphragm, and from the sheath of the right rectus muscle as low down as the umbilicus. The **round ligament** extends from the umbilicus (it is a fibrous cord, resulting from the obliteration of the umbilical vein), along the under surface of the liver, to the inferior vena cava. The broad ligament is formed by a fold of peritoneum. The

coronary and right and left lateral ligaments connect the posterior border of the liver with the diaphragm.

The under surface of the right lobe of the liver presents three lobes and three fissures. The square lobe (lobus quadratus) and the lobe of Spigelius are separated from each other by the transverse fissure. The square lobe lies anteriorly between the longitudinal fissure and gall bladder; and the lobus Spigelii, posteriorly, between the longitudinal fissure and inferior vena cava. The caudate (tailed) lobe (lobus caudatus) is only a small portion of the liver, which connects the lobus Spigelii with the main part of the right lobe, on the under surface. The under surface of the right lobe also presents two shallow depressions; one in front, which covers the hepatic flexure of the colon, and one behind, which covers the right kidney and capsule.

The left lobe of the liver rests upon the stomach (the front of the stomach), and extends into the left hypochondriac region, and sometimes as far as the upper border of the spleen. The left lobe is thin and flat.

The left and right lobes of the liver are sometimes joined together beneath the round ligament, as well as above, by a prolongation of hepatic substance (the pons hepatis, "liver bridge"); but this is only another way of saying that the round ligament (or umbilical vein of the fœtus) sometimes *runs through the liver*, instead of beneath it.

At the junction of the right and left lobes, on the under surface, is the commencement of the **transverse fissure**, which extends into the right lobe about five centimeters (two inches), and **contains** the primary branches of the portal vein, hepatic artery, hepatic duct, nerves and lymphatics. The older anatomists considered this fissure the gateway (porta) of the liver, and called the large vein which enters at this point the **portal vein** (vena portæ).

The **cystic** (gall bladder) **fissure** is an oblong fossa on the anterior part of the under surface of the right lobe, parallel with the longitudinal fissure. It extends from the anterior border of the liver backward to the transverse fissure. The fundus of the gall-bladder usually projects slightly beyond the anterior free margin of the liver.

The **caval** (for the vena cava) **fissure** is a short, deep fissure, occasionally a complete canal, on the posterior border of the liver, for the passage of the inferior vena cava. It is while lying in this fissure against the substance of the liver that the vena cava receives the hepatic veins. These veins usually terminate by two large and several smaller branches.

The nerves of the liver are derived chiefly from the sympathetic and pneumogastric nerves.

The substance of the liver consists principally of liver (hepatic) cells which secrete the bile, arranged in minute groups (or lobules), and held together by blood-vessels, ducts, and lymphatics. The ducts from the lobules are the **biliary** (bile) **ducts.** These unite to form the **hepatic** (liver) **duct.** The hepatic and cystic (gall bladder) ducts unite and form the **ductus communis choledochus** (the common bile-duct). These ducts are all, in one sense, biliary, since they all convey bile, but bear distinctive names. The biliary ducts terminate in two trunks — one from the right and one from the left lobe of the liver. These unite (forming the hepatic duct) at the transverse fissure on the under side of the liver, pass downward about four centimeters (one and one-half inches), and join the cystic duct from the gall bladder, to form the **common bile-duct.** The latter is the common excretory duct of the

Fig. 274.

THE UNDER SURFACE OF THE LIVER.

1, 2. Longitudinal Fissure.
3. Transverse Fissure.
4. Gall Bladder.
5. Vena Cava.
6. Right Lobe.
7. Left Lobe.
8. Lobus Spigelii.
9. Lobus Caudatus.
10. Lobus Quadratus.

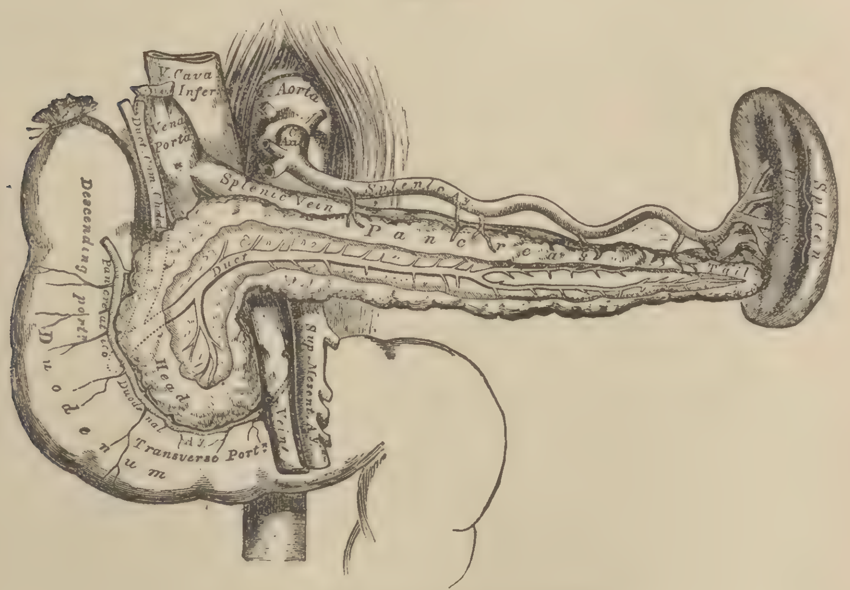
liver and gall bladder. It is about eight centimeters (three inches) in length, and of the diameter of a small goose-quill. It usually empties, by a common orifice, with the pancreatic duct into the descending portion of the duodenum, passing obliquely between its mucous and muscular coats. The **cystic duct** is about an inch (two or three centimeters) in length, and passes obliquely downward and to the left from the neck of the gall bladder to join the hepatic duct from the liver. It has an arrangement of its lining mucous membrane, presenting the appearance of a **spiral valve,** which is peculiar to the human subject. The **gall bladder** is a reservoir for the bile. It is ten centimeters (four inches) in length, and holds thirty or forty cubic centimeters (an ounce

or more). It lies under the liver immediately below the tenth costal (rib) cartilage. Whether the bile enters the gall bladder through the cystic duct, or through some *more direct* means, is uncertain. In some instances the cystic duct has become closed by a gall-stone, and the bladder has become, it was said, largely distended in consequence. See "Holden's Anatomy." These cases, if correctly reported, are evidence of other means of ingress for the bile; or, possibly, the distention arises from the mucous secreted by its inner coat, which is said to be abundant. The blood *from which the bile is secreted* is carried to the liver **by the portal vein**, while that destined for the *nutrition of the organ* is carried by the **hepatic artery.**

THE PANCREAS.

The pancreas (all flesh) is a glandular organ, that secrets the pancreatic juice, which is nearly identical with the saliva. It lies transversely across the epigastric region behind the stomach, extending from the descending portion of the duodenum on the right to the

Fig. 275.



THE PANCREAS, AND ITS RELATIONS.

spleen on the left. The splenic, or left extremity, which is small and tapering, is called the tail, and the larger extremity, at the right, is called the head.

The pancreatic duct (canal of Wirsung) conveys the pancreatic juice, usually by one opening, but sometimes two, into the duodenum, which lies against the head of the pancreas. Usually, the pancreatic and common bile-ducts open into the small intestine by a common orifice, but sometimes separately. The average weight of the pancreas is about ninety-three grams (three ounces).

THE SPLEEN.

The spleen is a gland, but possesses no excretory duct. For this reason it is classified with the thyroid, thymus, and supra-renal as a ductless gland. It is situated in the left hypochondriac (under the cartilage) region, at the left of the stomach, under the ninth and tenth ribs. It extends from the diaphragm above to the splenic flexure at the transverse colon below.

The color of the spleen is a dark bluish-red, or reddish-blue, while the pancreas is a reddish-cream color. The lungs are pink, or pinkish-white in youth, but in old age often mottled with gray, or dark slate.

The spleen is of oblong, flattened form, and weighs normally, on an average, two hundred and seventeen grams (seven ounces); although it is subject to great fluctuations in size, weighing, occasionally, nine kilograms (nine thousand grams, or twenty pounds). It is held in position by two folds of peritoneum: one, the gastro-splenic omentum, connects it with the stomach; and the other, the suspensory ligament of the spleen, connects it with the under surface of the diaphragm. It is also connected to the left kidney by loose areolar tissue. The splenic artery connects it with the cœliac axis and aorta, while the splenic vein, which helps to form the portal vein, connects it with the liver. The inner concave surface of the spleen has a vertical fissure, called the hilum (issue, or eye), which is pierced by several apertures for the entrance and exit of vessels and nerves.

The spleen and kidneys contain Malpighian (pronounced Mal-pe-ge-an, with the "g" hard) bodies (corpora), or corpuscles (little bodies). The **Malpighian bodies** of the spleen are very large in well-fed animals, but in starved animals disappear altogether. They vary in size and number, and differ materially from those of the kidney. Each body consists of a membranous capsule, containing a soft, semi-fluid white substance, consisting of granular matter, or nuclei, and a few nucleated cells. The nerves of the spleen are derived from the semi-lunar ganglia of the sympathetic system and the pneumogastric nerves. The office of the spleen is still involved in obscurity. One author calls it a **blood-lymph gland**, or blood-vessel gland. By some it is consid-

ered the *grave* of the red corpuscles of the blood; but it is more likely the **birthplace of the ganglionic nerve-cells**, as it is known to possess some mysterious influence over the nerves, and manifestations of mind.

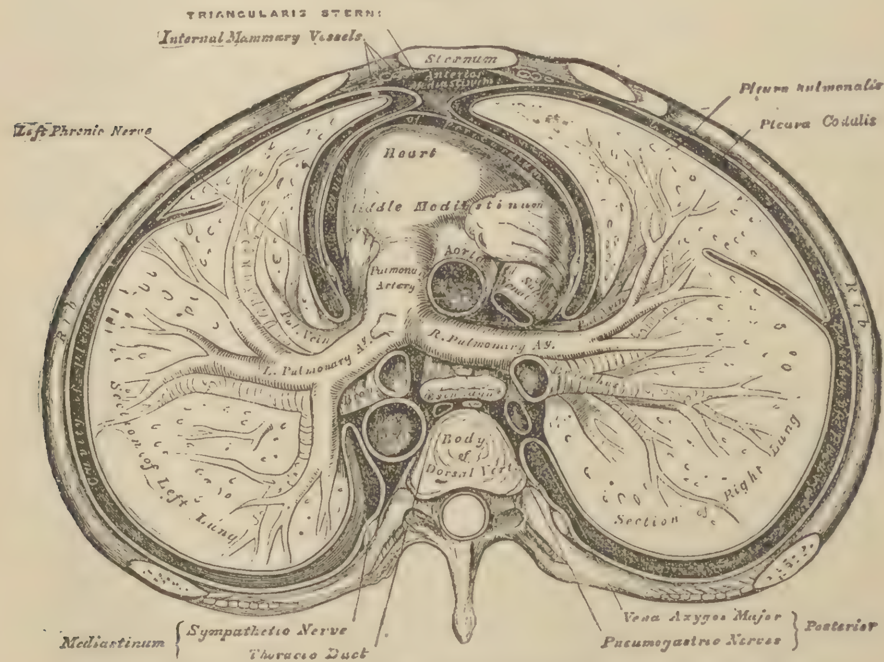
Mesenteric glands. These organs belong to the lymphatic system. They are situated between the layers of the mesentery, among the branches of the mesenteric arteries and veins. They vary in number from one hundred to one hundred and fifty; and in size, from a pea to that of a small almond. They are most numerous near the extremities of the small intestine. The lower group become infiltrated and greatly enlarged in bad cases of typhoid fever. Consumption of these glands is called "tabes mesenterica" (mesenteric decay). It occurs most frequently in children whose nutrition is badly managed.

ORGANS OF VOICE AND RESPIRATION.

THE THORAX.

THE thorax (cuirass, or coat of mail), called, also, the chest, forms one of the great splanchnic (visceral) cavities, and is destined to lodge and protect the chief organs of respiration and circulation,—the lungs and heart.

Fig. 276.



A TRANSVERSE SECTION OF THE THORAX, SHOWING THE REFLECTIONS OF THE PLEURÆ, THE MEDIASTINUM, ETC.

The chest is a bony and cartilaginous framework, situated at the front and sides of the bodies of the dorsal vertebræ (the twelve bones of the back). Its walls are formed by the ribs, costal cartilages, sternum, and dorsal vertebræ. It is bounded above on each side by the upper border of the first rib; below by the diaphragm, which separates

it from the abdomen. The apex of each lung projects through the upper opening of the chest a little above the first rib. The parts which pass through the upper opening are six muscles (the sterno-hyoid, sterno-thyroid, and longus colli, on either side), the trachea, thoracic duct, œsophagus, arteries, veins and nerves, and, in early life, the thymus body.

THE LUNGS.

The two lungs are the essential organs of respiration. They are sometimes called "lights," because when not diseased they float in water. The right lung has three lobes; the left, two. The base of each lung rests upon the convex surface of the diaphragm. The space between the lungs is called the mediastinum. It is divided by the heart into anterior, middle, and posterior mediastina (plural of mediastinum). The heart occupies the middle mediastinum.

The **anterior mediastinum** is bounded by the sternum in front, by the pericardium (heart-case) behind, and by the pleura, which covers the lungs on each side. It contains the remains of the thymus gland, the internal mammary vessels, and the origins of three pairs of muscles which lie behind the sternum.

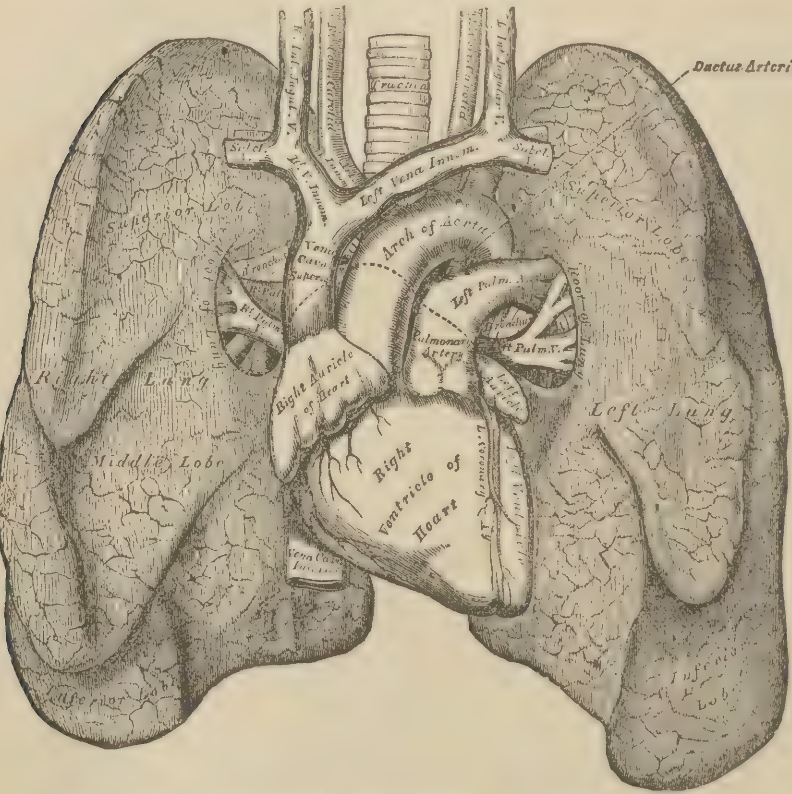
The **middle mediastinum** contains the heart and pericardium, the ascending aorta, the superior vena cava, the bifurcation of the trachea (windpipe), the pulmonary vessels, and phrenic nerves.

The **posterior mediastinum** has the heart and pericardium in front, the pleura at each side, and the vertebral column behind. It contains the descending aorta, the azygos veins, the pneumogastric and splanchnic nerves, the œsophagus, thoracic duct, and some lymphatic glands.

The **root of each lung** is formed by the bronchus (large air-tube) and blood-vessels which enter the lung a little above the middle of the inner surface of each lung, and connect it to the heart and trachea (windpipe). With the exception of the root the surface of each lung is free, and moves in the cavity of the thorax (chest). The **color of the lungs** is usually a light pink, but *is altered by the condition of the blood.* The bronchus is one of the two tubes which arise from the bifurcation of the trachea (windpipe), and conducts the air from the trachea to either lung. Both tubes together are called the bronchi (plural of bronchus). The bronchial tubes are subdivisions, or ramifications of the bronchus, and terminate in the alveoli, which contain the air-cells of the lungs. The bronchial tubes are lined with mucous membrane, and are supplied with a muscular coat, which forms a layer

of annular fibers. Each air-cell has a diameter of about one one-hundredth of an inch (one fortieth of a centimeter). The air-cells themselves are lined by pavement epithelium; but the mucous membrane of the tubes (bronchial tubes) that conduct the air to the lungs, is lined with columnar ciliated epithelium; *i. e.*, a layer of cells in the form of columns, or rods, standing on end, and covered at the free surface with

Fig. 277.



FRONT VIEW OF THE HEART AND LUNGS, AND LARGE BLOOD-VESSELS.

fine, hair-like projections, called cilia. Pavement epithelium is a layer of flattened cells. Besides the air-cells and air-passages, the lungs contain the pulmonary and bronchial vessels, nerves, lymphatics, and elastic tissue. The **pulmonary vessels** carry the blood of the entire system from the right ventricle to the left auricle of the heart, through the substance of the lungs. The **bronchial vessels** comprise the bronchial arteries and veins. The bronchial arteries, usually three in number, derived from the thoracic aorta, supply the parenchyma (substance) of the lungs for nutrition. The bronchial veins return the

PULMONIC CIRCULATION.

(Opp. Page 390).

blood from the substance of the lungs through the vena azygos and superior intercostal vein to the upper vena cava and right side of the heart.

The nerves of the lungs are derived from the pneumogastric, cervical, and sympathetic.

Each lung is covered by a serous membrane, called the **pleura** (a Greek word signifying "the side"). Each pleura is a shut sac, containing the plural cavity, which, in health, is scarcely a cavity at all, since that portion (visceral portion) which invests the lung lies in close contact with the parietal (wall) portion that lines the chest. A fold of pleura binds the root of the lung to the upper surface of the diaphragm. The pleura secretes a thin fluid, which facilitates the motion of the lung in the chest.

THYROID GLAND.

This organ is one of the so-called ductless glands. It is considered by some a blood-vessel gland. It is situated in the neck in front of the trachea (windpipe), lying across the upper part of the trachea and lower part of the larynx. It is just below Adam's apple (pomum Adami). It consists of two lobes joined by an isthmus. Its normal weight is about fifty grams (one or two ounces). The isthmus is one or two centimeters (half an inch) in breadth, and lies transversely across the third or fourth ring (or cartilage) of the trachea. Each lateral lobe is about two inches (five centimeters) in length, and extends from the lower horns (cornua) of the thyroid cartilage to the level of the fifth ring of the trachea.

The thyroid gland is subject to great enlargement in certain localities (usually at the bases of lofty mountains); forming a "goitre" (from "guttur," throat), which is often called bronchocele (tumor of the windpipe). There seems to be a communication between the thyroid gland and larynx. Lalouette, a French writer, says that the thyroid gland is frequently affected with **aerial tumors** (air swellings); and Haller informs us that Borden inflated the thyroid gland from little orifices in the first ring of the bronchus. Mr. Foderé inflated the gland from the larynx, secured below by a ligature.

In structure the thyroid gland somewhat resembles the lungs.

The arteries of the thyroid gland are remarkable for their large size and frequent anastomoses (intercommunication). The arteries are the superior and inferior thyroid, and sometimes an additional branch from the innominate.

THYMUS GLAND.

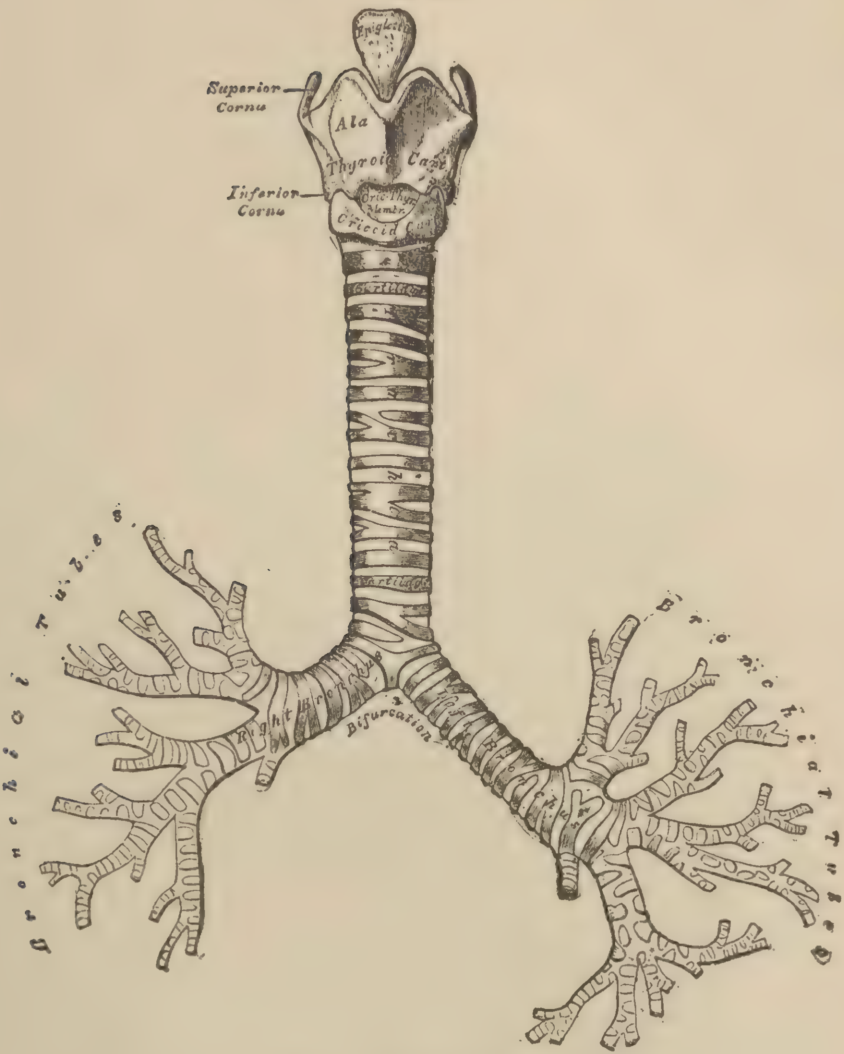
The thymus gland is a **temporary organ**, attaining its full size at the end of the second year, and nearly *disappearing at puberty.* It lies below the thyroid, and partly in the chest (the anterior mediastinum). It is five centimeters (two inches) in length, and one centimeter (about one third of an inch) in thickness. At birth it weighs about fifteen grams (one half ounce). It has a central cavity, which is prolonged into subordinate cavities. The cavities contain a fluid resembling chyle ("juice,"—the nutritive fluid taken up by the lacteals). No duct has been described, and it is usually classed with the supra-renal capsules, spleen, and thyroid gland, as "ductless."

THE TRACHEA.

The trachea (air-tube), or windpipe, is a cylindrical tube extending from the lower part of the larynx opposite the fifth cervical vertebra to the level of the third dorsal (back) vertebra, where it divides into two branches (the right and left bronchus), that carry air to the lungs. It lies partly in the neck and partly in the chest, being in front of two or three lower cervical, and as many upper dorsal vertebræ. The œsophagus (food-carrier) passes down behind it. The trachea is a fibrous tube, with rings of **elastic cartilage** so imbeded as to prevent the tube from collapsing. The rings, however, are incomplete, being open behind like a horseshoe, the incomplete portion being supplied with a more yielding membrane in front of the œsophagus. The rings number sixteen to twenty in the trachea, six or eight in the right bronchus, and from nine to twelve in the left—the left bronchus extending a little lower down before it enters the left lung. The trachea is eleven or twelve centimeters (four and one-half inches) long, and about two centimeters (four fifths of an inch) in diameter. It is larger in the male, and can be readily felt in the neck below the thyroid cartilage (Adam's apple). The **right bronchus** is two or three centimeters (one inch) long, the left nearly twice as long. The bronchi subdivide into small and smaller tubes, which finally open into the **alveoli** (little cavities) of the lungs, that contain the air-cells; that is to say, the air-cells are grouped together in sacculated cavities, called alveoli.

The trachea is lined with mucous membrane, which is continuous with the lining of the larynx above, and is covered on its free surface with columnar ciliated epithelium (layers of cells resembling rods set on end and covered with fine hairs [cilia]).

Fig. 278.



LARYNX, TRACHEA, AND BRONCHI.

THE LARYNX.

The larynx is the principal organ of voice. It is situated at the front part of the neck, and forms a prominence known as Adam's apple (pomum Adami), and also a part of the anterior boundary of the pharynx (throat). At the upper part it has the form of a triangular box, with one angle directly in front. It is composed of **nine cartilages**, moved by muscles, and lined by mucous membrane. Six of its

cartilages are in pairs; three are single. The three single cartilages are the thyroid, cricoid, and epiglottis; the three pairs are the arytenoid, cuneiform, and the cornicula laryngis. The latter are sometimes parts of the arytenoid.

The **thyroid** (θυρεος, a shield) **cartilage** is the largest, and consists of two halves, that meet in front and form an angle; but separate behind so as to inclose a space where several of the remaining cartilages are found. The two halves of the thyroid are called plates (lamellæ), or wings (alæ). The inner surface of each wing (ala) is smooth,

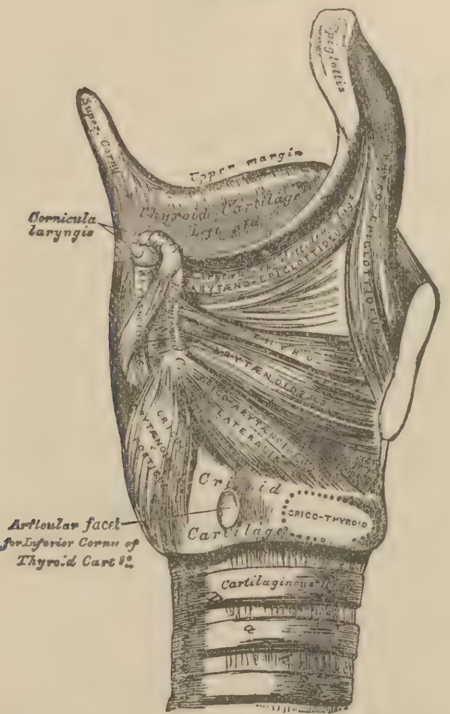
Fig. 279.

SIDE VIEW OF THE LARYNX, AND TWO RINGS OF THE TRACHEA.

concave, and covered by mucous membrane. At their junction in front, near the upper border, and on the inner surface, is attached the **epiglottis**, which serves to close the glottis during the act of swallowing (deglutition). Just below the attachment of the epiglottis, and near the anterior median line, the anterior ends of the vocal cords are attached. The upper border of the thyroid cartilage is deeply notched in front, and terminates posteriorly, on either side, in a horn (cornu), which projects upward. To the upper border is attached the membrane (thyrohyoid), which connects the thyroid cartilage with the hyoid bone. Each upper horn gives attachment to a ligament (the thyro-hyoid), which connects the thyroid cartilage with the hyoid bone.

The lower border of the thyroid cartilage is connected in front to the cricoid (ring-like) cartilage below by a membrane (the crico-thyroid), and at the side by a muscle (the crico-thyroid muscle), which increases the tension of the vocal cords by drawing down the thyroid cartilage over the cricoid. The lower border of the thyroid cartilage also terminates posteriorly on each side, in a horn (cornu), which projects downward; or, we may say in other words, the two posterior borders of the thyroid cartilage terminate above in two superior horns

Fig. 280.



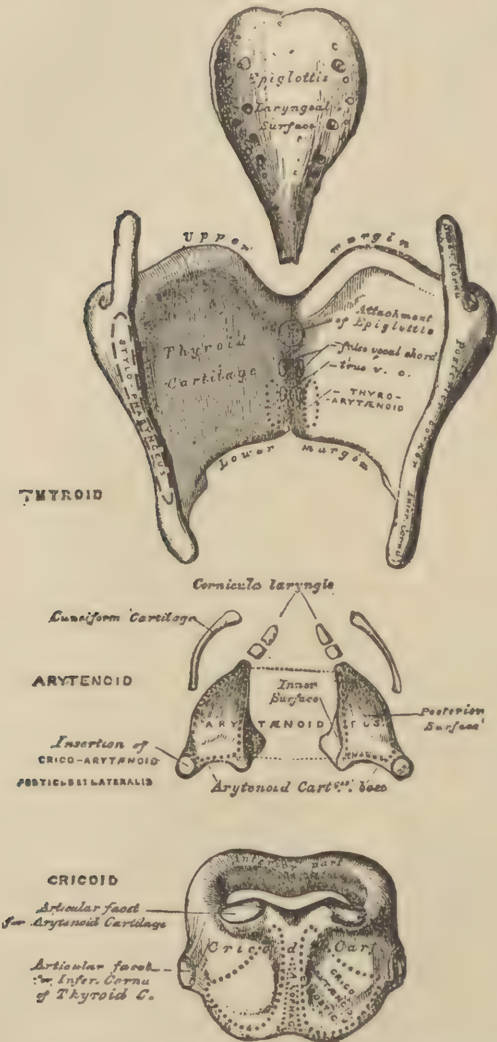
SIDE VIEW OF THE MUSCLES OF THE LARYNX. RIGHT WING OF THE THYROID CARTILAGE REMOVED.

(cornua), and below in two inferior horns. The inner surfaces of the inferior horns articulate with the outer surface of the cricoid cartilage,—or, in other words, embrace the cricoid. The outer surface of the thyroid cartilage gives attachment to a muscle (the sterno-thyroid) connecting it with the sternum, to another (the thyro-hyoid) connecting it to the hyoid bone, and to a third (the inferior constrictor of the pharynx) which assists deglutition (swallowing).

The **cricoid** (ring-like) **cartilage** forms the lower and back part of

the larynx. Its anterior part is narrow, but its posterior is much deeper and broad, so as to present the appearance of a signet ring, with the signet, or seal, placed behind. The lower border of the cricoid is con-

Fig. 281.



POSTERIOR VIEW OF THE CARTILAGES OF THE LARYNX.

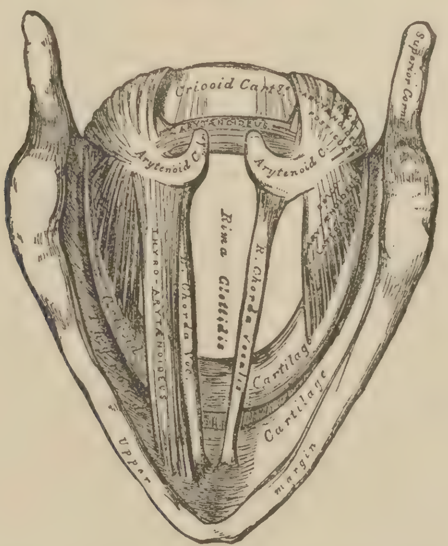
nected with the first ring of the trachea, by fibrous membrane. The upper border is connected, in front, with the thyroid cartilage above; at the side, to the lateral cryco-arytenoid (connecting the cricoid and arytenoid cartilages) muscle; and on each side of the median line

behind, by two articular surfaces, with the arytenoid cartilages, to which are attached the posterior extremities of the vocal cords.

The two **arytenoid** (ladle-like) **cartilages** are situated posteriorly above the cricoid, and serve, by approximation, to diminish the aperture of the glottis. The two cornicula laryngis (little horns of the larynx) are mere nodules of cartilage, situated at the apex of each arytenoid cartilage, and *sometimes* united to the latter; in which case the number of cartilages in the larynx is diminished to seven.

The **cuneiform** (wedge-form) **cartilages** are two small elongated bodies, placed one on each side in the fold of mucous membrane that extends from the apex of the arytenoid cartilage to the side of the epiglottis.

Fig. 282.

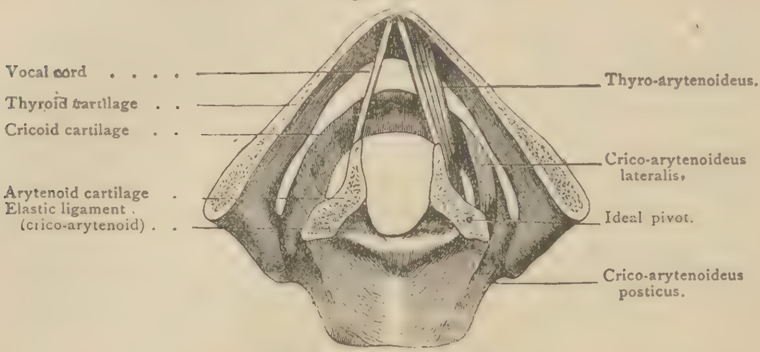


INTERIOR OF THE LARYNX — SEEN FROM ABOVE (ENLARGED).

The **epiglottis** (signifying "upon the glottis") is a cartilaginous lid, which closes the opening (the glottis) of the larynx during deglutition (swallowing). It has the form of a leaf, broadest at the top, and attached by its stem to the inner surface of the thyroid cartilage in front. During respiration it is nearly vertical, with its upper free extremity curving forward toward the base of the tongue; but during the act of swallowing, the larynx is drawn upward beneath the base of the tongue, so as to carry the epiglottis backward and downward, and completely close the glottis (the aperture in the larynx between the vocal cords).

The **glottis** (signifying the "mouth-piece of a flute") is an oblong aperture, always narrow in front, but wider or narrower behind, as may be necessary to modify the voice. It is nearly an inch (two and one-half centimeters) in length in the male, but shorter in females and children, whose voices are on a higher key. The glottis, or rima glottidis (chink of the glottis) is the interval between the **vocal cords.**

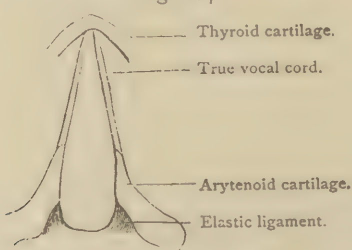
Fig. 283.



THE GLOTTIS DILATED.

There are two sets of vocal cords,— upper and lower, or false and true. The false vocal cords are the upper. They are two folds of mucous membrane inclosing a delicate ligament (the superior thyro-arytenoid), which runs parallel with the true vocal cords, but somewhat above them, and is not directly concerned in the production of the voice. Between the upper and lower vocal cords, or false and true, is the **ventricle** (little cavity) **of the larynx.**

Fig. 284.



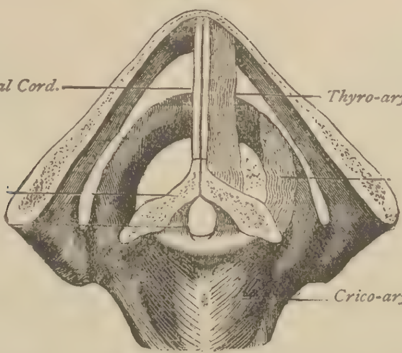
SHAPE OF THE GLOTTIS WHEN AT REST.

The lower, or **true vocal cords** are also called the inferior thyro-arytenoid ligaments (because each connects the thyroid cartilage in front with the arytenoid behind). Each cord consists of a band of yellow elastic tissue, covered by a thin layer of mucous membrane, so that the cords are not bare, like the strings of an instrument, but veiled by a fold of mucous membrane, that leaves an aperture (the glottis) only between the cords.

The larynx has in all eight intrinsic muscles,—five of the glottis and three of the epiglottis,—all taking their names from the cartilages to which they are attached. Those of the glottis are the crico-thyroid, crico-arytenoid (lateral), crico-arytenoid (posterior), arytenoid, and thyro-arytenoid; and those of the epiglottis are the thyro-epiglottic (the usual name is "thyro-epiglottideus"), lower aryteno-epiglottic and upper aryteno-epiglottic (or aryteno-epiglottideus superior).

The crico-thyroid muscles tighten and elongate the vocal cords, by drawing down the thyroid cartilage over the cricoid. The lateral crico-arytenoid muscles close the glottis, by rotating the base of the arytenoid cartilages inward, so as to approximate the posterior extremities of the

Fig. 285.



GLOTTIS, CLOSED, AND MUSCLES CLOSING IT.

vocal cords. The posterior crico-arytenoid separate the vocal cords (open the glottis), by rotating the base of the arytenoid cartilages outward. The arytenoid (a single muscle) assists the lateral crico-arytenoid, by approximating the arytenoid cartilages by direct action. It closes the glottis. The thyro-arytenoid muscles shorten and relax the vocal cords, by drawing the arytenoid cartilages forward. The upper aryteno-epiglottic muscles constrict the superior aperture of the larynx during deglutition. The thyro-epiglottic and lower aryteno-epiglottic muscles depress the epiglottis, and compress the **sacculus laryngis** (or laryngeal pouch). The latter is a membranous sac, placed above the true vocal cords, into which open sixty or seventy small glands, that secrete a fluid intended to lubricate the vocal cords. The sac is a prolongation of the ventricle of the larynx.

The nerves which supply the larynx are branches of the pneumogastric and sympathetic. The special branches of the pneumogastric are the superior and inferior laryngeal nerves. The inferior laryngeal is also called the recurrent laryngeal, on account of its direction. The latter supplies nearly all the muscles of phonation (action, or use of the voice).

THE URINARY ORGANS.

THE urinary organs comprise the kidneys, ureters, bladder, and urethra. The two kidneys secrete the urine; the ureters convey it to the bladder, which is a reservoir, situated and protected from undue compression, within the bony pelvis; and the urethra discharges the secretion from the body.

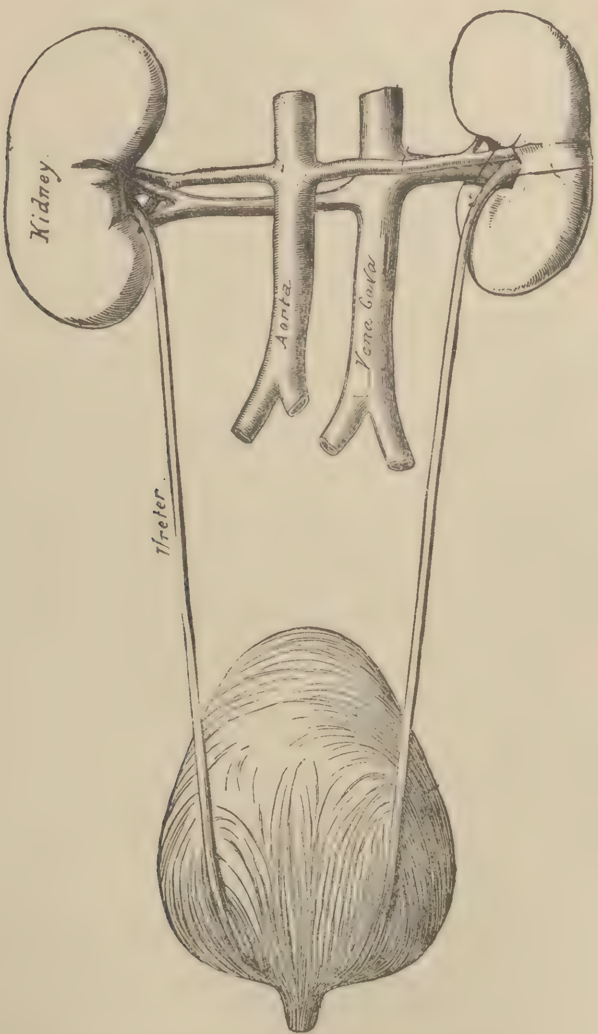
The **kidneys** (Greek, "nephroi") are situated, on either side, at the back part of the abdominal cavity, above the posterior crest of the ilium, partly in the hypochondriac region, and partly in the lumbar, and in front of the posterior portion of the eleventh and twelfth ribs. The right kidney is usually a little lower than the left, on account of its vicinity to the liver, the greater part of which lies in the right side of the body. The left kidney is usually the larger. In shape, the kidney resembles the kidney bean, the eye of the bean corresponding to the hilum of the kidney (hilum is properly the scar, or mark, left upon a seed at the place where the seed-stalk separates; it is the umbilicus of the seed). The hilum of the kidney is the notch, or fissure, on the inner concave border, where the blood-vessels, ureter, and nerves pass into and from the organ. The outer (or external) border of the kidney is convex, and directed outward, toward the walls of the abdomen. Each kidney is about ten centimeters (four inches) long, five centimeters (two inches) broad, and one or two centimeters (one inch) in thickness. It weighs about one hundred and fifty-five grams (five ounces), being larger in the male. The left is generally heavier by about eight grams.

The kidney is covered by dense fibro-areolar tissue, which forms its **capsule.** At the hilum the capsule is continued inward, lining the sides of the sinus (or pelvis of the kidney), and at the bottom of the pelvis, or sinus, forms sheaths for the blood-vessels and branches of the excretory duct (the ureter).

The **pelvis,** or sinus, occupies the interior of the kidney, and forms the tunnel-like expansion of the ureter as it enters the kidney. The pelvis at its widest part divides into three infundibula (tunnel-shaped cavities), and these in turn are sub-divided by papillary (nipple-like) projections into smaller cavities (called chalices [cups]).

A vertical section of the kidney reveals two distinct portions of its substance,—the cortical (bark, or outer), and the medullary (central) portion. The central part, next to the pelvis, consists of ten or twelve

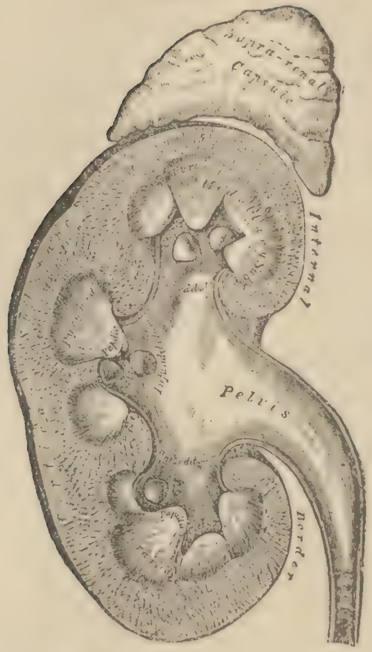
Fig. 286.



THE KIDNEYS, URETERS, AND BLADDER.

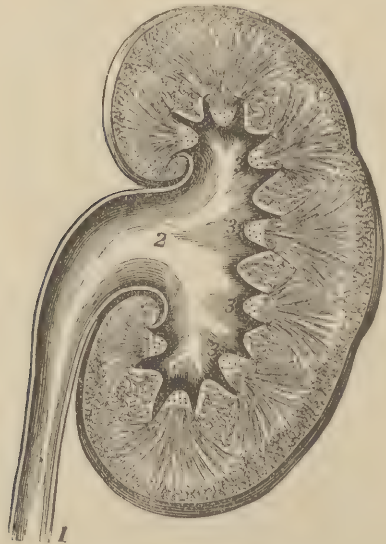
conical-shaped bodies, which are termed the "**pyramids of Malpighi**" (pronounced Mal-pe-ge, with the "g" hard). The bases and sides of the bodies are surrounded by the cortical substance; their apices project into the chalices (cups) at the margin of the pelvis, and are called

Fig. 287.



SECTION OF THE KIDNEY AND SUPRA-RENAL CAPSULE.

Fig. 288.



SECTION OF THE KIDNEY.

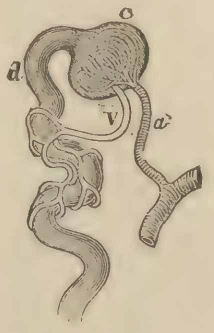
1. The Ureter. 2. Pelvis of the Kidney. 3. Papillæ.

papillæ (or papillary projections). Each pyramid consists of a large number (estimated at one thousand) of diverging tubules (little tubes), bound together by fibrous tissue containing blood-vessels. These tubules of the pyramids are the **tubuli uriniferi** (urine-bearing tubes) of the kidney. They open by thousands of minute orifices at the surface of the papillæ into the cups (chalices) of the infundibula.

The cortical substance consists of small, reddish corpuscles (little bodies) and convoluted tubules, imbedded in a fibrous stroma (bed), which contains vessels and nerves. The convoluted tubules are continuous with the tubuli uriniferi of the pyramids. The corpuscles of the cortical substance are termed **Malpighian bodies, or glomeruli** (little balls). **Two distinct offices** are assigned to the corpuscles and tubules. The *corpuscles* act *as filters*, while the epithelium, which

Fig. 289.

Fig. 290.



MINUTE STRUCTURE OF THE KIDNEY.

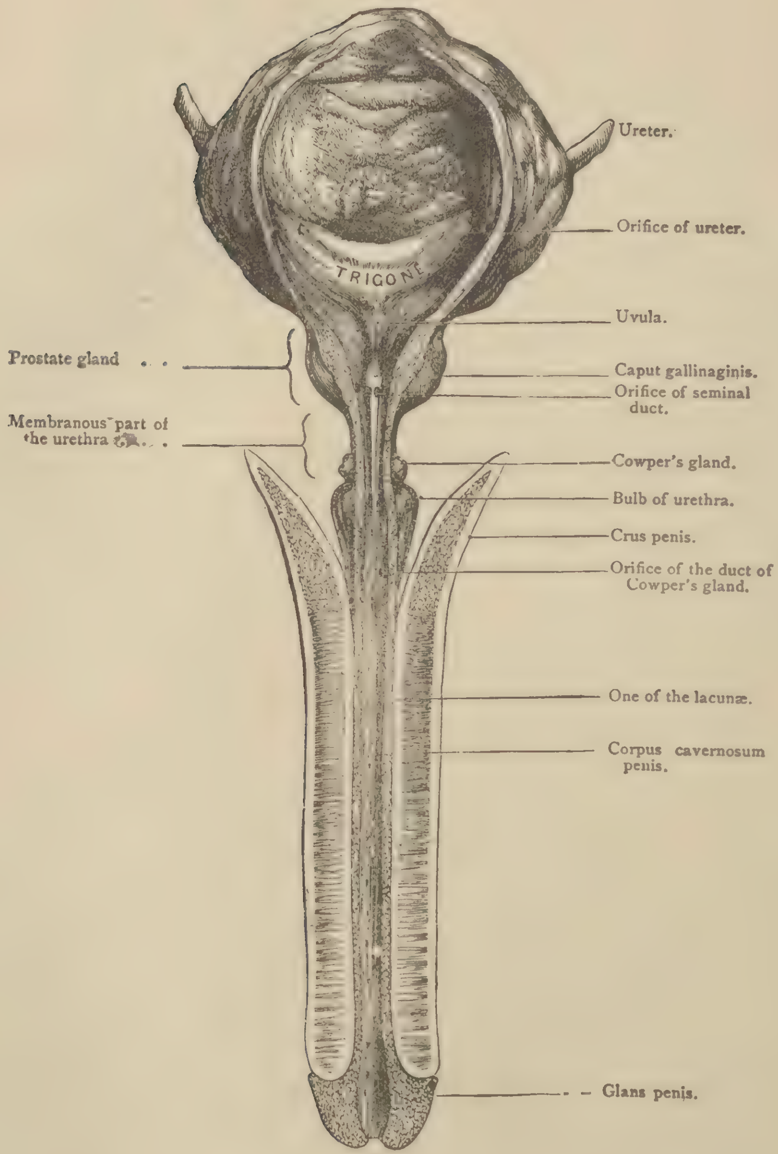
a. Artery. V. Vein, or Efferent Vessel. *c.* Capsule. *d.* Urinary Tube.

lines the tubules, is composed of secreting cells. The cells which line the tubules and corpuscles are nucleated. Each Malpighian corpuscle is composed of a capsule, and an inclosed tuft of blood-vessels and capillaries. The blood-vessels that enter the corpuscles are branches of the renal artery. The efferent (outward bearing) vessels of the corpuscles make up the veins.

The nerves of the kidney are derived from the renal plexus, which is formed by filaments from the solar plexus and lesser splanchnic nerve—all being branches of the sympathetic system.

The **ureter** is a membranous tube extending from the kidney, on either side, to the lower part of the bladder. It is about forty centimeters (sixteen inches) in length, and of the size of a goose-quill, and forms the excretory duct of the kidney. In its course from above, downward, it rests upon the psoas muscle, *behind the peritoneum*. It

Fig. 291.

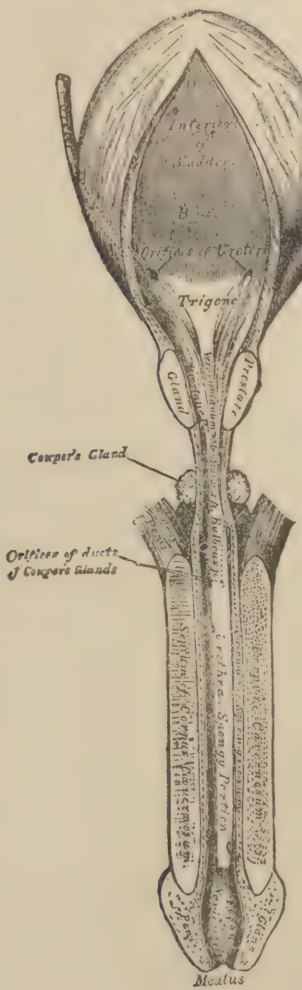


THE BLADDER AND URETHRA LAID OPEN.

passes obliquely downward and inward, enters the cavity of the pelvis, pierces the outer coats of the bladder, runs obliquely between its outer and inner coats for two or three centimeters (nearly an inch), and opens at the posterior angle of the trigonum (the triangular

space between the orifices of the two ureters and the urethra), about five centimeters (two inches) from its fellow of the opposite side. The ureter is composed of three coats — fibrous, muscular, and mucous. The mucous coat is continuous with that of the bladder.

Fig. 292.



THE BLADDER AND URETHRA LAID OPEN.

The **bladder** is a reservoir for the urine until the accumulation of a certain quantity in the bladder solicits and procures its expulsion from the body. The bladder is situated in the hypogastric region, between the pubes and rectum, in the male; but in the female the vagina *intervenes* between the bladder and rectum. It is a musculo-membranous

sac, and when moderately distended contains two hundred and thirty-six cubic centimeters (half a pint) or more.

The shape, position, and relations of the bladder vary with age, and the degree of distension. During infancy it is conical in shape, and projects above the upper border of the pubes. In the adult, when empty and contracted, it is triangular, and placed more deeply in the pelvis. When slightly distended it has a rounded form, and partially fills the pelvic cavity; when greatly distended it is egg-shaped, and rises above the pelvis into the abdominal cavity, so as to be plainly felt above the pubes.

The upper part of the bladder is called the summit, or apex, and is *attached to the umbilicus* by a suspensory ligament called the **urachus.** In some animals the urachus is a membranous canal, which arises from the bladder, makes its exit from the abdomen at the umbilicus, and terminates during fœtal life in the allantois (the allantois is a sort of elongated bladder, formed between the two membranes [the amnion and chorion] that surround the fœtus). Occasionally the urachus has been found pervious at birth, so that the urine escapes at the umbilicus; but this is a malformation.

The summit of the bladder inclines forward toward the umbilicus, or some point between that and the pubes. The part opposite the summit is called the *base*, or fundus (bottom) of the bladder. The base of the bladder rests, in the male, upon the second portion of the rectum; in the female, upon the neck of the uterus (cervix uteri) and the anterior wall of the vagina.

The **neck of the bladder** is the narrow, constricted portion at the commencement of the urethra, which is the excretory duct *from the bladder*. The bladder is held in place by ligaments,—five true and five false. The latter are formed by folds of peritoneum.

The **ten ligaments** are two anterior, two posterior, four lateral, and two superior. The five true ligaments are the two anterior, two lateral, and one superior (the urachus).

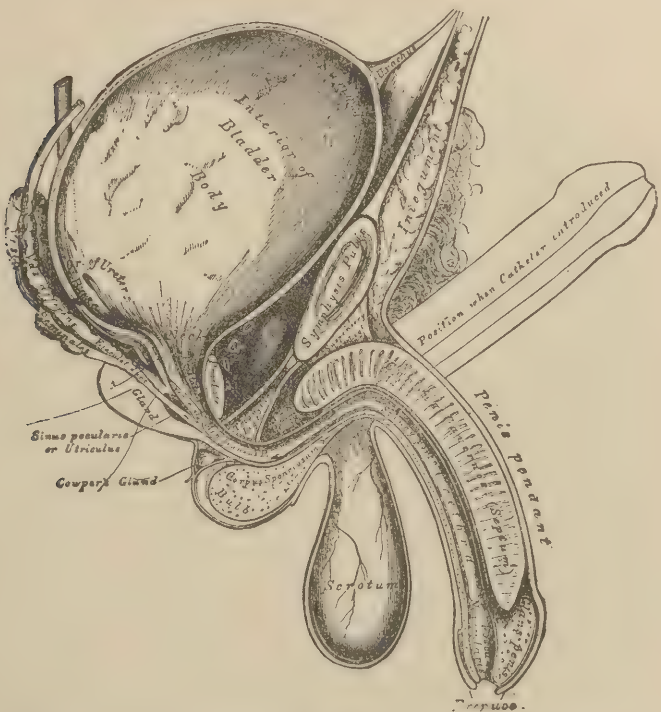
The ligaments connect the bladder to the prostate gland, rectum, uterus of the female, pubes, sides of the pelvis, and to the umbilicus. The posterior ligaments contain the obliterated hypogastric, or umbilical arteries of the fœtus. The superior false ligament is a fold of peritoneum, which covers the urachus (the superior ligament) from the summit of the bladder to the umbilicus.

The bladder has four coats,—serous, muscular, alveolar (this coat is often called cellular), and mucous. The serous coat is partial only, since the peritoneum does not invest the anterior surface of the bladder. The areolar coat connects the muscular and mucous coats. The mucous

coat is thin and smooth, and provided with a few mucous follices. The epithelium covering it is intermediate in form between the columna and pavement varieties.

Upon the inner surface of the base of the bladder is a triangular, smooth surface between the openings, or orifices, of the two ureters and the urethra, which is called the **trigonum vesicæ** (triangle of the bladder). Its apex is upward and forward, toward the urethra. The triangle lies in intimate relation with the rectum, and it is in this space that puncture of the bladder through the rectum is sometimes performed.

Fig. 293.



VERTICAL SECTION OF THE BLADDER, PENIS, AND URETHRA.

The **urethra** is the common urinary canal; and in the male, is also the common spermatic canal. It extends from the neck of the bladder to the meatus urinarius (urinary passage). It is about twenty-one centimeters (eight or nine inches) long in the male, but less than five centimeters (two inches) in the female, and forms a curve beneath the arch of the pubes, with the concavity directed upward. In the female this curve is slight, as the urethra lies embedded in the anterior wall of the vagina; but in the male it is considerable, so that the male

catheter (an instrument for drawing off the fluid contents of the bladder) is introduced with more difficulty. Its diameter when undilated is about six-tenths of a centimeter (one quarter of an inch). The female urethra admits of considerable dilatation, so that calculi (stones, or concretions), or other foreign substances, are removed from the female bladder with greater facility.

The male urethra is divided into three portions,—the prostatic, membranous, and spongy. The **prostatic portion** is next to the bladder, and is surrounded by the prostate gland. It is about three centimeters (one and one-quarter inches) in length.

The **membranous portion** extends from the prostate gland to the bulb of the corpus spongiosum (spongy body) at the root of the penis. It is one or two centimeters (half an inch, or more) in length, and is surrounded by the compressor urethræ (compressor of the urethra) muscle.

The **spongy portion** of the male urethra is contained in the corpus spongiosum (spongy body) of the penis, and is about fifteen centimeters (six inches) in length. It extends from the membranous portion to the meatus urinarius (urinary passage), at the extremity of the glans penis. The urethra is lined with mucous membrane, which is continuous with the mucous membrane of the bladder, ureters, and kidneys.

The **supra-renal capsules** are usually described with the urinary organs, but their use is unknown. They are situated, one on either side, immediately in front of the upper end of the kidney; hence their name. In some individuals they are very small, in others, large. They are generally four centimeters (one and one-half inches) in length, a little less in width, and one centimeter (one quarter of an inch) in thickness. They are sometimes called atrabiliary (black bile) capsules, because believed by Galen and some other ancient physicians to be concerned in secreting black bile, and causing melancholy (black bile) and mania. They are now supposed to be connected with the sympathetic system. They are larger in the fœtus than in the adult, and have no excretory duct.

MALE GENITAL ORGANS.

THE principal male genital organs are the testes and penis. To these are generally added the prostate, and Cowper's glands, and the vesiculæ seminales. The principal male genital organs are external, while those of the female are internal; yet both are, *in part*, internal.

The seminal vesicles of the male are deeply situated in the pelvis, behind the bladder, and the excretory duct of the testis (or testicle) *enters the abdomen* through the inguinal canal, and passes through the pelvis, behind the bladder, to reach the urethra, through which the seminal fluid is discharged. The greater part of the excretory duct of the testis is called the **vas deferens** (outward bearing vessel, or, more literally, "vessel bearing from"),—a name which is entirely inappropriate to the first part of its course, which is *inward* from the testicle *to* the abdomen and pelvis. At the neck of the bladder, where its course is truly outward, and where it unites with the duct of the seminal vesicle (vesicula seminalis), it takes the name of the **ejaculatory duct.** The name, "vas deferens," is appropriate with reference to the testis (*from* which it bears the semen), but not with reference to the body.

The **prostate** (standing before) **gland** surrounds the neck of the bladder and first part (prostatic) of the urethra. In shape and size it resembles the horse-chestnut. It can be distinctly felt, especially when enlarged, as it often is in old age, through the rectum. It consists of three lobes, as usually described — two lateral and a middle lobe. The third lobe is not constant, but is occasionally found at an early period of life. The third (or middle) lobe is situated between the two lateral, at the under and back part of the organ.

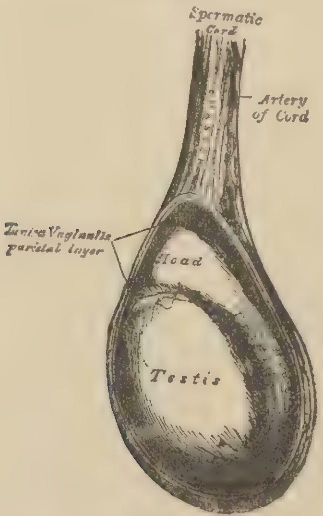
The prostate gland is perforated by the urethra and by the ejaculatory ducts, which open into the prostatic portion of the urethra. The gland itself has fifteen, or twenty, excretory ducts, which also open into the prostatic portion of the urethra. The fluid discharged from the prostate, by aid of muscular bands around the organ, not only lubricates the interior of the urethra, but serves as a vehicle (or medium) for the sperm secreted by the testes.

Cowper's glands are two small bodies, about the size of peas, placed beneath the membranous (second) portion of the urethra. Each has an excretory duct opening into the urethra. These glands diminish in size as age advances.

THE TESTES.

The testes ("witnesses," because they give evidence of virility, or power of procreation) are the **seminal glands** of the male. The are two in number, one on either side, and are suspended by the spermatic cord in the scrotum, beneath the pubes — the left usually hanging a little lower than the right. The testes are also called "testicles," which is only the diminutive of testes. In the Greek, the word for testicle is didymis; hence we have the word "epididymis," which signifies "upon the testicle."

Fig. 294.



THE TESTIS IN SITU (IN POSITION) AS IT HANGS IN THE SCROTUM.

Each testicle resembles in form and size a small hen's egg. It is protected by several external coverings, which may be mentioned as the scrotum, spermatic fasciæ, and tunica vaginalis; but each of these is divided into two layers. The two layers of the **scrotum** are the outer integument (the skin) and the dartos. The scrotum (signifying a "leathern bag") is itself a cutaneous bag, or pouch, formed by a prolongation of the skin of the inner part of the thigh, perinæum, and penis, and containing the testes and lower portion of the spermatic

cords. It is divided into two lateral halves by a median line, or raphe (suture or seam), which is continued along the middle line of the perineum. The scrotum is usually elongated and flaccid in old and debilitated persons; but in the young and vigorous, and especially under the influence of cold, it is short, and closely applied to the testes. The integument of the scrotum has a peculiar brown color, and is thrown into numerous rugæ (wrinkles) when the scrotum is contracted.

The **dartos** (skinned) is the contractile layer of the scrotum. It is very vascular, and contains involuntary muscular fiber. The dartos sends inward a prolongation (the "septum scroti"—partition of the scrotum), which divides the scrotum into two distinct cavities, one for each testis.

The two layers of spermatic fasciæ that cover the testes are the external and the internal spermatic fascia. The external spermatic fascia is also called intercolumnar ("between the pillars" of the external abdominal ring) fascia; and the internal is also called infundibuliform ("funnel-shaped," from the internal abdominal ring), or fascia propria.

The **tunica vaginalis** (sheath-covering), like other serous membranes, consists of a parietal and a visceral layer. The visceral portion covers the outer surface of the testis, while the parietal portion lines the inner surface of the dartos, or scrotum. The tunica vaginalis is really a prolongation of the peritoneum in the fœtus; but after birth the connection of the scrotum with the abdomen through the inguinal canal becomes obliterated, and the scrotum becomes a shut sac. The interval between the two layers of the tunica vaginalis constitutes the cavity of the tunica vaginalis, and is the seat of hydrocele (watery tumor). In addition to these six external coverings of the testicle, authors usually mention another — the cremaster (suspender) muscle, which consists of scattered bundles of muscular fibers, and is hardly worthy of mention as a covering. Its office is to draw up the testicle.

In order to a better understanding of the external coverings of the testis, it is necessary to mention that the testis is first formed in the abdomen, behind the peritoneum, and just before birth descends through the inguinal canal into the scrotum, carrying before it numerous coverings derived from the serous, muscular, and fibrous layers of the abdominal walls.

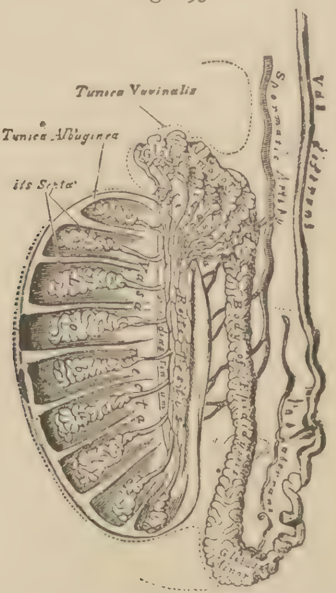
The testis is believed by some to be drawn downward from the abdomen by a cord, called the gubernaculum testis (governor of the testis), which extends from the testis to the scrotum and ischium.

Besides its seven external coverings, the testis itself has two other

coats (or tunics). These are the tunica albuginea (white coat) and tunica vasculosa (vascular coat). The white coat is fibrous. It gives shape and firmness to the testicle. The vascular tunic consists of a plexus of blood-vessels, held together by delicate areolar tissue, and covers the inner surface of the tunica albuginea.

At the posterior and upper border of the testicle (or testis) the tunica albuginea (the white, fibrous coat) is reflected into the interior of the gland, forming an incomplete vertical septum, called the mediastinum testis (middle space of the testis).

Fig. 295.

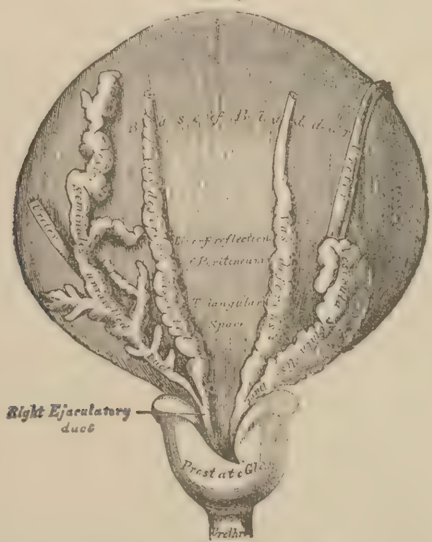


VERTICAL SECTION OF THE TESTIS, OR TESTICLE.

The interior of the gland consists of a great number of little lobes (lobules), each of which contains a few small, convoluted tubes (tubules), called **tubuli seminiferi** (seed-bearing tubes). The total number of these tubes is variously estimated, varying from 300 to 62,500; and their total length from 1,890 feet to 5,208 feet. Toward the posterior part of the gland the tubes become less convoluted, and by uniting, form twenty to thirty larger ducts, which, on account of their straight course, are called **vasa recta** (straight vessels). The straight ducts enter the mediastinum, and pass upward, forming in their ascent a close network of tubes, called the rete testis (net of the testis). At the upper end of the mediastinum the vessels, or ducts of the net, ter-

minate in fifteen or twenty ducts (the vasa efferentia, or outward bearing vessels), which perforate the white coat of the testis, and carry the seminal fluid to the **epididymis** (upon the testis). The epididymis consists of a convoluted tube twenty feet long or more, which by its complex convolutions forms the body of the epididymis. This body extends along the upper and posterior margin of the testicle, held in place by fine areolar tissue ; and at the lower end of the testicle, where it is called the **globus minor** (lesser globe), it opens into the **vas deferens** (vessel bearing from), which carries the seminal fluid upward through the inguinal canal into the abdomen and pelvis. The upper part of the epididymis is formed by the convolutions of the vasa efferentia (efferent vessels), and is called the **globus major** (greater globe, or ball).

Fig. 296.



BASE AND POSTERIOR SURFACE OF THE BLADDER, SHOWING THE URETERS, SEMINAL DUCTS, AND SEMINAL VESICLES.

The vas deferens forms a part of the spermatic cord till it enters the abdomen, then passes down into the pelvis behind the bladder, and uniting at the base of the bladder with the duct of the seminal vesicle forms the ejaculatory duct. The latter opens into the prostatic portion of the urethra.

The **spermatic cord** extends from the testis below to the internal abdominal ring (the inner orifice of the inguinal canal). It is composed of the vas deferens, which is one portion of the excretory duct of the testis, of arteries, veins, lymphatics, and nerves, all connected by areolar tissue, and invested by their proper coverings.

The arteries of the cord are the spermatic from the aorta, the artery of the vas deferens from the superior vesicle, and the cremasteric from the epigastric artery. The spermatic artery supplies the testicle. The nerves are derived from the sympathetic. The **seminal vesicles** (vesiculæ seminales) are two lobulated membranous pouches placed behind the bladder, between it and the rectum, and serve as reservoirs for the semen, like the gall bladder for the bile. They are six or seven centimeters (two and one-half inches) long, and one or two centimeters (one half inch) in breadth, but vary in size in different individuals. Each vesicle consists of a single tube, coiled upon itself, and held in place by fibrous tissue. When uncoiled this tube is about the diameter of a quill, and from ten to fifteen centimeters (four to six inches) long. It terminates posteriorly in a cul-de-sac (no opening), but its anterior extremity forms a narrow, straight duct, which unites with the vas deferens of the same side to form the ejaculatory duct. The latter passes forward and upward in the substance of the prostate gland one or two centimeters (three fourths of an inch), and opens into the urethra, which is thus made to form the final portion of the excretory duct of the testis.

The semen (seed), or sperm, is a thick, whitish fluid, which is secreted in part by the testes and in part by the prostate gland. It contains seminal granules and spermatozoa, or zoösperms (sperm-animals). The zoösperms are the essential agents in producing fecundation (or fruitfulness). They are minute, elongated particles with a long, slender caudal filament, resembling in shape and motion the tadpole. Such is the apparent beginning of human life.

THE PENIS.

The penis (tail) is the organ of copulation. It is situated in the median line of the body, in front of the pubic arch, and consists of a root, body, and extremity, or glans (signifying "acorn," from its shape). The root is attached by two strong, fibrous processes to the rami (branches) of the pubis, and by a fibrous membrane to the front of the symphysis pubis. At the extremity of the glans is the orifice of the urethra (the meatus urinarius). The base of the glans forms a rounded border, called the corona glandis (crown of the glans). The body is the part between the glans and the root. The body is covered with integument, which at the root is continuous with that which covers the pubes; but at the crown leaves the surface, and becomes folded upon itself, so as to form the prepuce (foreskin), which was, among some nations, removed by circumcision (cutting around).

The prepuce is attached to the lower part of the meatus urinarius (urinary passage), and forms the frenum (bridle). The body of the penis consists of three portions, or three fibrous compartments, which, when distended with blood, give the form of a triangular prism with rounded angles, but in the flaccid condition the organ is cylindrical. The three compartments are named the spongy body (corpus spongiosum) and the two cavernous bodies (corpora cavernosa). The two latter lie side by side along the upper surface, or dorsum (back) of the penis, while the spongy body runs forward beneath the two cavernous bodies, and expands into the glans, or head, which covers the ends of the cavernous bodies. The spongy portion contains the urethra, which conveys the semen to the meatus urinarius (urinary passage). These three bodies are composed of erectile tissue. The spongy body terminates near the root of the penis, in what is called the bulb, which varies in size in different subjects.

Erectile tissue consists of a great number of anastomosing veins. The superficial lymphatic vessels of the penis terminate in the inguinal glands; the deep lymphatics pass beneath the pubic arch, and enter the pelvis.

FEMALE GENITAL ORGANS.

THE principal genital organs of the female are the ovaries, uterus, or womb, and the mammæ (breasts). The ovaries and uterus are internal; the mammæ, external. To these—the principal organs—must be added, for a full description, the vagina (sheath) and the volva (fold of integument, from volvo, "to roll," more frequently written "vulva").

The mons Veneris (mount of Venus) is the eminence which surmounts the volva, and at puberty becomes covered with hair.

The labia (lips), larger and smaller, are folds of integument inclosing the common urino-sexual opening. The more external folds are called the labia majora, and the internal, labia minora, or nymphæ. (Nympha signifies a spouse, or bride.) Sometimes the greater and sometimes the lesser lips are most prominent.

The anterior and posterior commissures are the extremities of the common fissure, or opening.

The clitoris is a small erectile organ, situated just within the anterior commissure. Between the clitoris and the entrance of the vagina is a triangular smooth surface, between the nymphæ, called the vestibule. Within the vestibule, and near the anterior margin of the vagina, is the orifice of the urethra (meatus urinarius). Below the vestibule is the orifice of the vagina (sheath), which leads to the os uteri (mouth of the uterus).

In early life the vagina is usually more or less closed by a membranous fold, called the hymen (god of marriage). The hymen sometimes forms a complete septum across the orifice of the vagina, and constitutes an imperforate hymen. In other cases it is circular, with a small opening in the center, or, it may be, stretched across the lower part only of the orifice, and may be entirely absent.

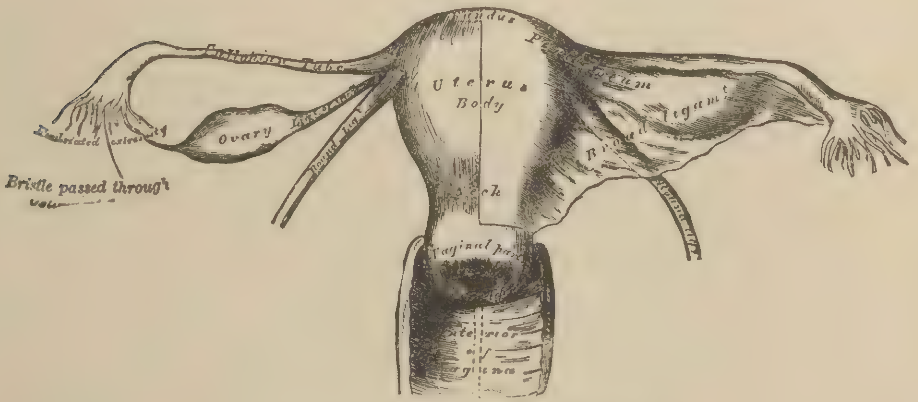
The vagina (sheath) is a canal extending from the volva to the uterus, or womb. It is about twelve centimeters (five inches) in length, being somewhat curved, and longer on its posterior border. It surrounds, or embraces, the lower portion of the neck of the uterus (cervix uteri), and gives exit and entrance to the womb. It has a muscular coat, a layer of erectile tissue, and an internal mucous lining. At

the commencement of the vagina on each side is an oblong body (the gland of Bartholine), which is analogous to Cowper's gland in the male. It has an excretory duct opening upon the inner side of the nympha.

The **uterus** (metra) is the organ of gestation. It is situated in the pelvis between the bladder and rectum, and resembles, in shape and size, a flattened pear. The broader, upper portion is called the fundus (bottom); and the lower, contracted portion, the neck (cervix). The neck projects partly into the vagina, and forms the mouth of the uterus (os uteri), which is the external orifice of the uterine cavity. The cavity also communicates with the two Fallopian tubes (or oviducts).

The uterus is held in place by folds of peritoneum, which connect it with the bladder, rectum, and sides of the pelvis; and, also, by two true ligaments (the round), which extend from the superior angle of the uterus, on either side, through the inguinal canal, to the labia majora

Fig. 297.



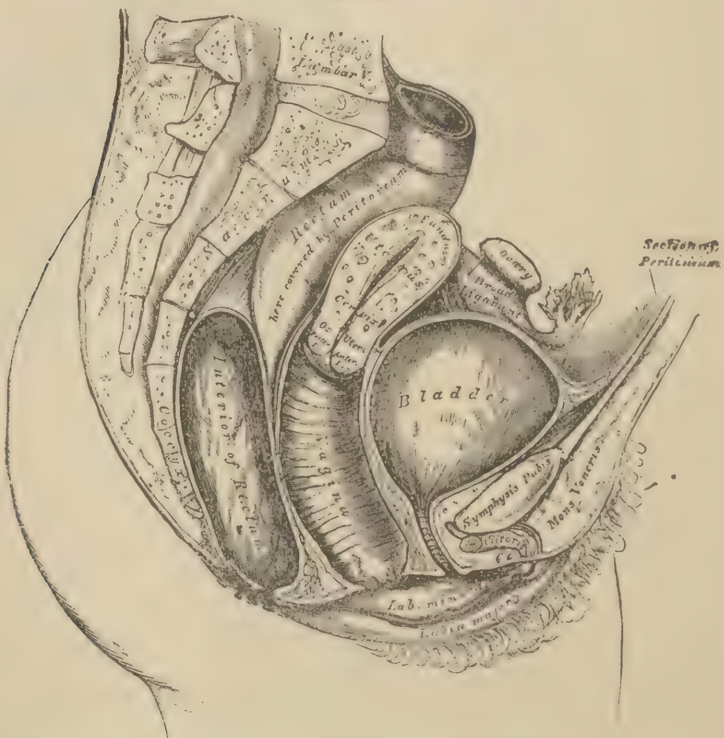
THE UTERUS AND ITS APPENDAGES.

(greater lips). The folds of peritoneum that serve as uterine ligaments are six in number,—two broad ligaments, two anterior, and two posterior. The anterior connect with the bladder, the two posterior with the rectum, and the two broad ligaments with the walls of the pelvis. The latter (the broad ligaments) invest the body of the womb, as the mesentery does the bowel, and extending outward to the sides of the pelvis, inclose, separately, the round ligaments, the ovaries and Fallopian tubes, and form a septum across the pelvis in front of the rectum. The tubular process of the peritoneum (or broad ligament), which incloses the round ligament as it passes through the inguinal canal, has been called the canal of Nuck (Antony Nuck), although it is seldom a distinct canal, except in the fœtus.

The broad ligament forms the external serous coat of the uterus; the middle coat, which forms the bulk of the substance of the uterus (or womb), is muscular, and the internal is a mucous coat.

During gestation (or pregnancy) the muscular coat becomes more prominently developed, and the womb constantly increases in size till near the period of parturition (labor, or delivery). The mucous membrane extends into the Fallopian tubes (oviducts), and at their fimbriated (fringed) extremity becomes continuous with the peritoneum ; and

Fig. 298.



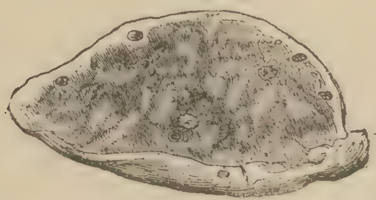
SECTION OF THE FEMALE PELVIS, SHOWING POSITION OF VISCERA.

through the os uteri, the mucous membrane is continuous with the lining of the vagina. The mucous membrane is lined with columnar ciliated epithelium. The cervix (neck) of the womb is provided with mucous follicles, and some glands (the glands of Naboth).

The arteries of the uterus are the uterine and ovarian, derived, respectively, from the internal iliac and aorta. They are remarkable for their tortuous course, which is a provision for the change which takes place in the size of the organ during gestation. The veins are of

large size, and correspond with the arteries. In the gravid (heavy) uterus the veins are termed **uterine sinuses.** The ovaries and Fallopian tubes are generally described as appendages of the uterus; but it would be more correct to speak of the Fallopian tubes and uterus as appendages of the ovaries, since the ovaries represent the bird that lays the egg; while the uterus is only the nest where the egg is hatched. The **ovaries** (egg-producers) are two bodies somewhat analogous to the testes of the male. They are situated one on each side of the uterus, are inclosed by the broad ligament, and connected to the uterus by a proper ligament (ligament of the ovary), and to the fimbriated extremity of the Fallopian tube by a short cord. The ovaries are somewhat smaller than the male testes. The proper covering of the organ is a dense, firm, fibrous coat (the tunica albuginea), which incloses a soft, fibrous tissue abundantly supplied with blood-vessels. Imbeded in the meshes of this tissue, and composing the main substance of the ovary, are numerous small, round, transparent vesicles

Fig. 299.



SECTION OF THE OVARY.

(the Graafian vesicles), in various stages of development. These Graafian vesicles are the ovisacs which contain the ova (eggs). The matured vesicles are found near the surface of the ovary, ready to burst through, like a plant through the surface of the ground.

The **ovum** (egg), in a perfectly matured vesicle, measures about one one-hundred and twentieth of an inch in diameter. Liberated from the ovary by the periodical bursting of one or more Graafian vesicles, the ovum is taken up by the fimbriated (fringed) extremity of the Fallopian tube and conveyed to the interior of the uterus, where it remains for a few days, and then, when unimpregnated, passes through the cervix and os uteri into the vagina, as an excretion; but when fecundated in the uterus by the male sperm, or spermatozoid, it becomes attached to the inner surface of the womb, and is called the **embryo.** The Fallopian tube (Gabriel Fallopius) is about ten centimeters (four inches) in length. Its canal is very minute, and will scarcely admit a fine bristle. One on each side extends from the superior angle of the

uterus to the free margin of the broad ligament. The maturing of an ovum and the rupture of a Graafian vesicle at the surface of the ovary, is recorded upon the ovary by the appearance of a scar, or yellow spot, which has been called the "**corpus luteum**" (yellow body),—and some have affirmed that the impregnation of the ovum materially changes the character of the corpus luteum; but this assumption is no more probable than the erroneous belief that the absence of the hymen is evidence of the loss of virginity.

THE MAMMÆ (Breasts).

The mammæ are the glands that secrete the milk. In the male they are usually rudimentary, but in some instances are said to have been developed. They are two large eminences, one on either side, beneath the integument, external to the great pectoral muscle (pectoralis major), and separated only by a layer of fascia. Their weight and dimensions differ in different individuals and at different periods of life. They enlarge at puberty, during pregnancy, but more especially after delivery, and become atrophied (wasted), as a gland, in old age. The nipple (or teat) is a conical, erectile eminence upon the summit of the gland where the numerous lactiferous (milk-bearing) ducts all terminate. The nipple itself is dark-colored, and is surrounded by a colored circle, called the areola (little space). In the young virgin the areola has a delicate pink, or rosy hue; after impregnation it acquires a darker tinge, usually a dark-brown color.

The **mammary gland** consists of numerous lobes and lobules (small lobes), connected by areolar tissue, blood-vessels and ducts. The lobules consist of a cluster of vesicles, which open into the lactiferous ducts. The number of excretory ducts varies from fifteen to twenty. They are termed the tubuli lactiferi (milk-bearing tubes). These tubes converge toward the center of the breast, and beneath the areola form dilatations, which serve as reservoirs for the milk; but at the base of the nipple they become contracted again, and pursue a straight course to its summit, where they open by several small orifices.

Fatty tissue surrounds the surface of the gland, and occupies intervals between its lobes; and it is the fatty tissue which largely determines the form and size of the mammæ. The arteries are derived from the thoracic branches of the axillary, the intercostals, and the internal mammary. The lymphatics of the mammæ terminate in the axillary glands.

FŒTAL CIRCULATION.

THE fœtal circulation differs materially from that of the adult, chiefly because the blood is not aerated in the lungs till after birth. The arterial blood, for the nutrition of the fœtus, is brought from the placenta of the mother along the umbilical cord, by means of the umbilical vein, and is carried directly to the liver, which in the fœtus is, proportionally, very large. At the liver a portion of the blood is distributed directly to that organ, a portion enters the liver mixed with the blood from the vena portæ, and a third portion passes through a canal peculiar to the fœtus (the "**ductus venosus**," or venous duct), directly into the vena cava, which carries the blood to the right side of the heart. At the right side of the heart the blood from the inferior vena cava is guided by the Eustachian valve, which is peculiarly developed, through an opening (the "foramen ovale") peculiar to the fœtal heart, directly into the left auricle, without passing through the lungs, as it does in the adult; whilst the blood from the superior vena cava descends over the Eustachian valve into the right ventricle. From the right ventricle the blood enters the pulmonary artery; but instead of going to the lungs in any considerable quantity, the greater part passes through a canal, or duct (the **ductus arteriosus**, or arterial duct) peculiar to the fœtus, directly into the descending aorta, where it unites with a small quantity of blood transmitted from the left ventricle. The greater part of the arterial blood from the placenta, mixed with the blood from the inferior vena cava, reaches the arch of the aorta through the ductus venosus, foramen ovale, and left ventricle of the heart, and is distributed to the head and upper extremities, which are proportionally large and well developed at birth; while a small portion is carried, by the descending aorta, to the abdomen and lower extremities.

The greater part of the blood transmitted by the descending aorta to the internal iliac arteries is venous blood, on its way back to the placenta, which it reaches by means of two vessels (the umbilical, or **hypogastric arteries**) peculiar to the fœtus, and which help to form the umbilical cord. The umbilical arteries arise from the internal iliacs, in addition to their usual branches, in the adult, ascend along the sides

of the bladder of the fœtus to the umbilicus, pass out of the abdomen, and coiling round the umbilical vein of the cord, reach the placenta.

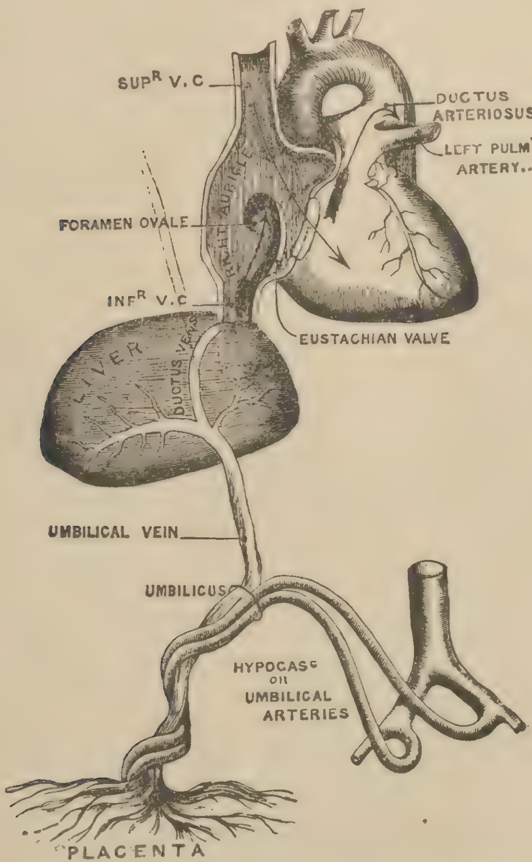
To sum up the principal peculiarities of the fœtal circulation, we notice, first, the fact that the function of respiration is latent, the blood

Fig. 300.

PLAN OF THE FŒTAL CIRCULATION.

of the fœtus being aerated in the lungs of the mother, and reaching the fœtus through the placenta and the umbilical vein of the umbilical cord; second, that the arterial and venous blood are less distinct (more freely mingled) than in the adult; and, third, a difference in the anatomical structure of the vascular system.

Fig. 301.



ANOTHER VIEW OF THE FŒTAL CIRCULATION.

The principal anatomical peculiarities are, first, the existence of the foramen ovale, which opens direct communication between the right and left sides of the heart; second, the peculiar development of the Eustachian valve, which turns the current of blood from the inferior vena cava directly into the left side of the heart; third, the ductus arteriosus (a short tube about one centimeter [one half inch] in length), which connects the left branch of the pulmonary artery with the arch of the aorta; fourth, the umbilical, or hypogastric arteries, which

extend from the internal iliacs along the umbilical cord to the placenta; and, fifth, the ductus venosus, which opens communication between the umbilical vein and inferior vena cava.

At birth, the pressure of the atmosphere inflates the lungs; the placental circulation is cut off in the umbilical cord; the blood from the pulmonary artery passes through the lungs; the ductus arteriosus begins immediately to contract, and in a few days becomes completely closed, but remains as a cord to connect the pulmonary artery to the arch of the aorta; the foramen ovale becomes gradually closed about the tenth day after birth; the umbilical arteries, between the third and fifth days, become obliterated, and form the anterior, true ligaments of the bladder; and in about the same time the umbilical vein and ductus venosus become obliterated, the umbilical vein becoming the round ligament of the liver, and the ductus venosus a fibrous cord connecting the liver with the inferior vena cava.

SURGICAL ANATOMY

THE word surgery is a contracted form of the obsolete word chirurgery, and signifies "hand-work," or **manual operations.**

A distinguished surgeon of France declared that operations were the "opprobrium of surgery;" and an equally distinguished physician of England declared, "It is our ignorance that renders operations necessary." Doubtless but for ignorance, the entire healing art would become obsolete, or be merged in a general and universal education.

The "setting," or adjusting of broken bones and dislocations belongs to surgery; but **surgical anatomy** treats only of the *structure of parts of the body* where manual operations are more frequently required.

Of surgical anatomy, the most important parts are those that relate to hernia (the protrusion of some viscus, or part, from its natural cavity); the tying of arteries; the removal of tumors, foreign bodies, and calculi (stones, or concretions); and the making of artificial openings for the introduction of air to the lungs, or for the escape of some superabundant secretion, or undue accumulation of waste-matter within some cavity or part of the body.

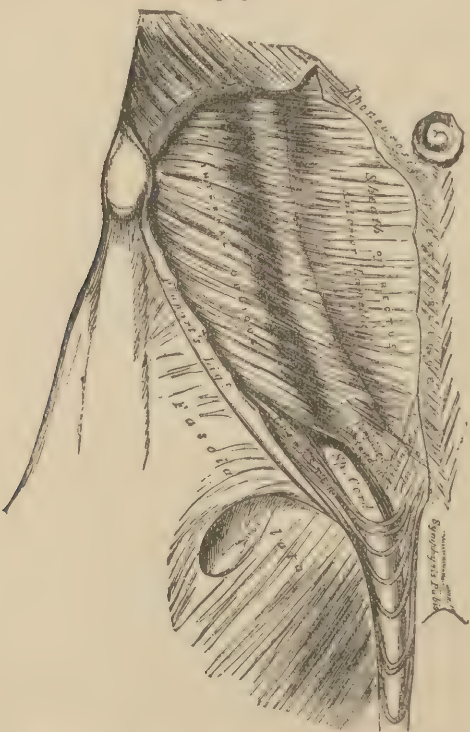
The **principal parts** embraced in surgical anatomy, are the inguinal regions, Scarpa's triangles, the triangles of the neck, the axillary space, the popliteal space, the perinæum, the abdominal and pleural cavities, the nasal passages, pharynx, and larynx.

In the inguinal regions, we find the inguinal and femoral canals, which are frequently the seat of hernia; in Scarpa's triangle, we find the femoral artery, and other large blood-vessels and nerves of the lower extremity; in the triangles of the neck, we find large and important blood-vessels and nerves that pass to and from the head and upper extremities; in the axillary space, vessels and nerves to the upper extremity; in the popliteal space, vessels and nerves to the leg and foot; in the perinæum we find access to the rectum and bladder; the abdominal (or peritoneal) and pleural cavities are frequently the seat of dropsical effusion; the nasal passages and pharynx are liable to be obstructed by foreign bodies and abnormal growths; and the larynx

and trachea are sometimes opened artificially for the introduction of air. For the benefit of the general reader we shall speak briefly of some of these parts, and refer medical students, for a more minute description, to the body of this work and treatises on surgery.

The word **hernia** signifies a sprout, or shoot, and is applied to the protrusion of any internal organ, or part, from its natural cavity. The three great cavities are those of the skull, chest, and abdomen. A protrusion of the contents of the skull and chest is somewhat rare, but **abdominal hernia** is more common. The latter is divided, according to the aperture by which the hernia escapes, into inguinal (groin), femoral (thigh) and umbilical (navel) hernia.

Fig. 302.



INGUINAL CANAL AND SPERMATIC CORD.

Inguinal hernia is situated in the inguinal region, and may be direct, or oblique. An **oblique inguinal hernia** follows the course of the inguinal canal, which lies obliquely in the groin, leaving the abdomen at the internal abdominal ring (entrance to the inguinal canal), and protruding, beneath the skin, from the external abdominal ring (the outlet of the canal).

Direct inguinal hernia does not escape through the internal abdominal ring and inguinal canal, but protrudes directly through the peritoneum (the firm membrane that covers the bowels beneath the skin) *and* the external abdominal ring. This form of hernia is rare.

The **inguinal canal** lies obliquely in the groin, just above Poupart's ligament, and nearly parallel with it. It is about one and one-half inches in length, and transmits the spermatic cord in the male, and the round ligament in the female. Inguinal hernia is more common in the male. The **spermatic cord** extends from the internal abdominal ring to the testicle. It is composed of the excretory duct of the testicle, arteries, veins, nerves, and lymphatic vessels. The cord is generally a little longer on one side than the other, so as to suspend one testicle a little lower than the other.

The **round ligament** of the uterus extends from the superior part of the uterus to the labia majora. It consists of a bundle of fibrous tissue, together with muscular fibers, vessels, and nerves, and all inclosed in a fold of peritoneum.

Poupart's ligament (called, also, the "crural arch") is a part of the aponeurosis (flattened tendon) of the external oblique muscle, and is continuous with the fascia lata (broad bandage) of the thigh. The **external abdominal ring** is not a ring, but a triangular interval in the aponeurosis of the external oblique muscle, but becomes more or less oval when distended by a hernia. The two sides of the triangular interval (called the external abdominal ring) are formed by the two "pillars of the ring," and its base by the pubic bone.

The two pillars (called also "columns" by some authors) of the external ring are bound together above by a set of aponeurotic fibers, which constitute the intercolumnar (between the columns) bands from which is derived a covering (called the intercolumnar, or external spermatic, fascia) for the emerging cord.

The **internal abdominal ring** is bounded above and externally by arched fibers of the transverse muscle, and beneath the arch is the sprout-like prolongation of the transversalis fascia (the infundibuliform) which invests the cord. This fascia (the infundibuliform, or transversalis) extends from the margin of the internal ring, and forms the fifth layer of all inguinal herniæ (plural of hernia). It incloses the cord and testicle (or testis) in a distinct pouch.

By placing the finger in the external abdominal ring, it will be noticed that extension and abduction (carries the leg outward from the median line) of the leg renders the crural arch tense, and constricts the external ring. It will, therefore, be relaxed by flexion and adduction of the leg.

The inguinal canal is formed between the time of birth and the age of puberty. At birth, the upper and lower openings of the fœtal ring (corresponding to the internal and external abdominal rings of the adult) are opposite to each other, and scarcely separated; and the spermatic cord of the infant runs in a straight line from the psoas muscle to the bottom of the scrotum, and passes through a mere aperture. As the fœtal ring becomes changed into the adult canal (the inguinal), the internal orifice changes its position, and ascends toward the spine of the ilium, by the gradual extension of the transversalis fascia which incloses the cord in the canal.

The passage of the testis (or testicle) through the inguinal canal usually takes place about the eighth month of intra-uterine life, but it may be delayed till months after birth. It may adhere to the colon, or abdominal wall, and it may be arrested in the inguinal canal, and be mistaken for hernia.

The cremaster muscle consists of fibers derived from the internal oblique muscle during the descent of the testis. The two pillars, or columns, of the external abdominal ring are formed by the separation into two parts of the tendon of the external oblique muscle.

In old hernias, the upper and lower orifices of the inguinal canal are sometimes brought opposite to each other by the absorption of the posterior side of the canal caused by pressure. In such cases the term oblique, or indirect, is no longer applicable.

Unless distended by hernia, the inguinal and femoral canals are simply flattened passages. In fœtal life, and, in many cases, for a month or so after birth, a tubular process of peritoneum extends from the internal ring to the bottom of the testicle. Before birth, or soon after, this vaginal (because it forms a sheath) process of the peritoneum becomes divided into two portions,—the superior (which incloses the cord), and the inferior, or vaginal process, which usually remains as a closed sac, covering the testicle throughout life. The superior portion of this process, peculiar to the spermatic cord, usually becomes obliterated, and its superior abdominal orifice permanently closed; but the time of the closure of this ventral orifice is not fully determined. Paletta says it takes place from the twentieth to the thirtieth day after birth. In case of hernia into the vaginal process of the peritoneum before the closure of this canal, the intestine and testicle touch each other, and are contained in the same sac. Such herniæ are called "congenital," and it is impossible to raise in such cases the hernial sac, and leave the testicle in place, since the latter is also contained in the hernial sac.

Femoral hernia is a protusion of some portion of the abdominal

contents through the femoral canal. This canal is situated beneath Poupart's ligament, while the inguinal canal is above it. It is a narrow interval on the inner side of the femoral vein, and is within the sheath (crural, or femoral sheath) that incloses the femoral vessels. It is a distinct canal only when the sheath has been separated from the vein by the pressure of a hernia, or tumor. It is a short canal, usually less than half an inch in length. Its upper opening leads into the cavity of the abdomen, and is called the **femoral, or crural ring.** Its lower opening in the fascia lata of the thigh is called the **saphenous opening,** (see Fig. 181) because it transmits the internal saphenous vein. The upper opening of the femoral canal is closed by the **septum crurale** (pronounced in three syllables), and the lower (the saphenous opening) is closed by the **cribriform fascia.** This fascia is called cribriform, because it is pierced by numerous small blood-vessels.

The coverings of inguinal and femoral hernia are somewhat different, yet they are all covered by the skin, superficial fascia, and peritoneal sac.

In addition to these, femoral hernia has, also, as a covering, the septum crurale, the femoral sheath, and the cribriform fascia, which are all peculiar to *femoral* hernia.

In addition to the common coverings mentioned above, both forms of inguinal hernia have, also, the intercolumnar fascia, the fascia transversalis, and the sub-serous cellular tissue.

Oblique inguinal hernia has, also, as a covering, the cremaster muscle; and direct inguinal hernia the conjoined tendon of the internal oblique and transversalis muscles.

The order of the coverings in all these hernias from without inward is as follows; viz., first, the skin; second, superficial fascia; third, in inguinal hernia (both forms) the intercolumnar fascia, and in femoral the cribriform fascia; fourth, in oblique inguinal hernia the cremaster muscle, in direct inguinal hernia the conjoined tendon of the internal oblique and transversalis muscles, and in femoral hernia the femoral sheath (fascia propria); fifth, in both forms of inguinal hernia the fascia tranversalis (or infundibuliform fascia), and in femoral hernia the septum crurale; sixth, in both forms of inguinal hernia the subserous cellular tissue, and in femoral hernia the peritoneal sac; and, seventh, in both forms of inguinal hernia the peritoneal sac.

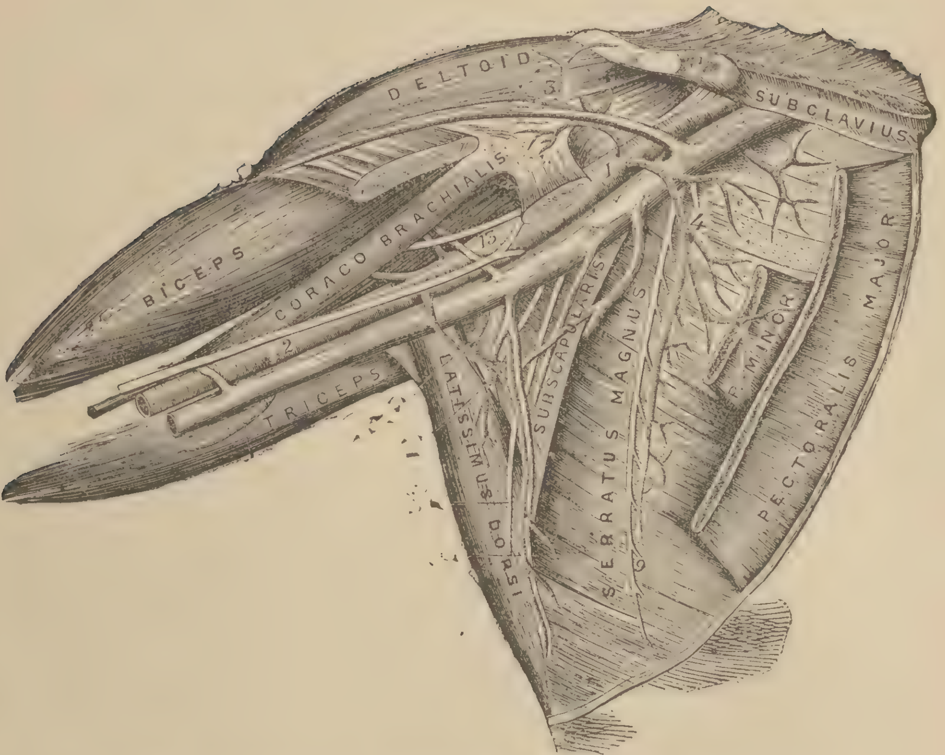
SCARPA'S TRIANGLE.

This region of surgical anatomy (see Fig. 146) corresponds to a triangular depression in the groin, and is formed by Poupart's ligament and the sides of two muscles (the sartorius and adductor longus). The floor of this space is formed by several muscles (iliacus, psoas, pectineus, and two adductors [longus and brevis]); and the space is covered by the skin, the fascia lata, and a portion of the sartorius muscle. The middle of this space is occupied by the femoral vessels (artery and vein). The femoral artery gives off in this space its cutaneous and deep branches, and the femoral vein receives the deep femoral and internal saphenous veins. The femoral vein lies in the upper part of the space at the inner side of the artery, and the anterior crural nerve (a very large nerve) lies about half an inch to the outer side of the artery; or in, other language, the artery lies *between* the vein and nerve. The artery and vein lie in the same sheath, but are separated by a thin partition of fibrous tissue. At the lower part of the space the vein passes down behind the artery to the outer side. In this situation the femoral vessels may be easily compressed, or tied.

THE POPLITEAL SPACE, OR HAM.

This is behind the knee, and occupies the lower third of the thigh and the upper fifth of the leg. Above, it is limited by the opposition of the inner and outer hamstring muscles. The tendon of the biceps forms the outer hamstring, and the tendons of four muscles (the semimembranosus, semitendinosus, gracilis, and sartorius) the inner hamstring. These muscles are supplied by the great sciatic nerve, and flex the leg upon the thigh. Below, the popliteal space is limited by the junction of the two heads of the gastrocnemius muscle. The floor of the space is formed by the posterior surface of the femur and tibia, the posterior ligament of the knee-joint, and the fascia covering the popliteus muscle, and the space is covered by the fascia lata and skin. The contents of the popliteal space (see Fig. 148) are the popliteal vessels (artery and vein), the termination of the external, or short saphenous vein, the popliteal nerves, the small sciatic nerve, small lymphatic glands, and loose adipose tissue.

Fig. 303.



THE AXILLARY SPACE, OR AXILLA (Armpit).

The position of this space is sufficiently obvious. It is bounded by muscles (anteriorly by the pectoral muscles, and posteriorly by the subscapular, teres major, and latissimus dorsi), and covered by the skin and two muscles (the pectoralis major and subclavian). The axillary space contains the axillary vessels (an artery and vein), the brachial plexus of nerves, and a large number of lymphatic glands.

The axillary artery (see Fig. 153) is a continuation of the subclavian, and takes its name at the lower border of the first rib, and terminates (changes its name to "brachial") at the lower border of the tendons of the latissimus dorsi and teres major muscles. Its direction varies with the position of the limb; when the arm hangs or lies by the side, the vessel forms a gentle curve with the convexity upward; when it is at right angles with the chest the vessel is nearly straight, and when uplifted, or elevated still more, the artery describes a curve again, but with the concavity directed upward. At its commencement the artery is deeply situated, but near its termination in the brachial is superficial, being covered only by the skin and fascia.

The popliteal artery in the first part of its course rests on the inner surface of the femur, but below on its posterior surface. The vein is more superficial than the artery, but they are closely connected.

TRIANGLES OF THE NECK.

All points of the neck on one side have corresponding points on the other side, which are symmetrically disposed with respect to the vertical median line in front. For this reason one description answers for both sides.

Now, on each side of the neck we have five triangles. Three of these are in front of the sterno-cleido-mastoid muscle, and two are behind it. (See Fig. 119.) The space in front of the muscle is called the *anterior* triangular space, and that behind is called the *posterior* triangular space. The latter extends to the anterior border of the trapezius muscle. Two other muscles (the omo-hyoid and the digastric) and the lower jaw also serve as boundaries. The omo-hyoid extends from the hyoid bone to the shoulder (to the upper border of the scapula). It has, like the digastric, two bellies, named, respectively, the *anterior* and *posterior* belly. It has also a central tendon, which is held in position by a process of the deep cervical fascia, which includes it in a sheath, and is attached to the cartilage of the first rib. The anterior belly is next to the hyoid bone, and in the upper part of its course is nearly vertical, while the posterior belly is more nearly horizontal.

The digastric muscle extends, in a curved form, from the symphysis menti (the median line of the chin where the two sides of the jaw unite) to the side of the head, just behind the ear (to the mastoid process of the temporal bone), its central tendon being attached to the hyoid bone.

Three of the triangles of the neck are named from contiguous bones,— the submaxillary, subclavian, and occipital; and two are named from the large artery of the neck,— the superior carotid and the inferior carotid.

Their names and boundaries are as follows, viz.:—

1. Submaxillary: lower border of the jaw, median line of the neck, and posterior belly of the digastric muscle.

2. Superior carotid: sterno-mastoid, omo-hyoid, and digastric muscles. (Its posterior belly.)

3. Inferior carotid: middle line of the neck, sterno-mastoid, and omo-hyoid muscles.

4. Occipital: trapezius, sterno-mastoid, and omo-hyoid muscles.

5. Subclavian: sterno-mastoid, omo-hyoid muscles, and clavicle.

The common carotid artery is found in the inferior carotid triangle, but extends into the superior carotid triangle, where it bifurcates.

The external and internal carotid arteries and facial vessels and nerve are found only in the submaxillary and superior carotid triangles.

The internal jugular vein and pneumogastric nerve are found in all the three triangles of the anterior space (space in front of the sterno-mastoid muscle).

The recurrent laryngeal nerve, trachea, and thyroid gland are found only in the inferior carotid triangle.

The larynx lies partly in each of the two carotid triangles.

The superior thyroid artery and vein are found only in the superior carotid triangle.

The lingual artery and vein are in the superior carotid triangle.

The external jugular vein is in the subclavian triangle.

The glosso-pharyngeal nerve, the temporal and internal maxillary artery and vein, and the parotid and submaxillary glands, are in the submaxillary triangle.

In the superior carotid triangle the carotid arteries are somewhat concealed from view by the edge of the sterno-mastoid muscle which overlaps them. The external and internal carotids lie side by side, the external at first on the inner side.

The **superior carotid triangle** contains important arteries, veins, nerves, and organs, viz.:—

ARTERIES.—Bifurcation of the common carotid, external and internal carotid, and five branches of the external carotid (superior thyroid, lingual, facial, ascending pharyngeal, and occipital).

VEINS.—The internal jugular, and those which open into it (superior thyroid, lingual, facial, pharyngeal, and sometimes the occipital).

NERVES.—Three cranial (the pneumogastric and one of its branches—the superior laryngeal; the hypo-glossal, and one of its branches—the descendens noni [descending of the ninth] and the spinal accessory), the sympathetic, and the external laryngeal (branch of the superior laryngeal).

ORGANS.—One symmetrical half of the lower part of the pharynx, and the upper part of the larynx.

The **inferior carotid triangle** also contains arteries, veins, nerves, and organs, viz.:—

ARTERIES.—Common carotid and inferior thyroid.

VEINS.—Internal jugular, middle thyroid, and vertebral.

NERVES.—Pneumogastric and a branch (the recurrent laryngeal), decendens noni, communicans noni, and sympathetic.

Organs.— Trachea, thyroid gland, and lower part of the larynx. One half of these lie on either side of the neck; *i. e.*, they lie in the median line.

The **submaxillary triangle** contains arteries, veins, nerves, and glands, viz.: —

Arteries.— External carotid, internal carotid, facial, sub-mental, and several smaller branches.

Veins.— Internal jugular, commencement of the external jugular, the facial, and those which open into it below the jaw; viz., the sub-mental, submaxillary, inferior palatine, and ranine.

Nerves.— Deeply situated at the back part of the space are the pneumogastric and glosso-pharyngeal.

Glands.— Portion of the parotid and submaxillary glands and lymphatic glands.

The **occipital triangle** contains the transversalis colli (transverse of the neck) artery and vein, the spinal accessory and cervical nerves, and lymphatic vessels and glands.

The **subclavian triangle** contains the third portion of the subclavian artery, the transversalis colli artery and vein, the brachial plexus and cervical nerves, the external jugular vein, and the subclavian when it ascends above the clavicle, and lymphatic vessels and glands.

THE PERINÆUM.

The perinæum (about the scrotum) may be briefly defined as the floor of the pelvis, or, indefinitely, as the parts in the region of the outlet of the pelvis; but more definitely, the perinæum may be described as consisting of two parts,— the *superficial* and *deep* perinæum, or perineal body.

The superficial perinæum is the triangular space at the outlet of the pelvis, bounded by lines connecting the tuberosities of the ischia (the lowest projections of the hip bones) with each other, and with the apex of the arch of the pubes. The deep perinæum (the perineal body) is a thick and firm, but irregular, triangular pyramid, whose base is formed by the superficial perinæum, and whose vertex, in the female, extends upward to the point of approximation of the rectum and posterior wall of the vagina. The perineal body is composed of fibro-elastic tissue, nerves, and blood-vessels. In the male, this body includes the prostate gland, Cowper's glands, the neck of the bladder, and the fixed portion of the urethra.

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